LIVE ARTICLES ON SPECIAL HAZARDS

No. 5

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LIVE ARTICLES

ON

SPECIAL HAZARDS

No. 5

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FOREWORD.

In presenting this volume, the fifth from our presses dealing with special hazards, it is pleasing to note the growing interest in this subject which is now taken by the public. Preventive measures are now recognized as of equal if not greater importance in insurance than the feature of indemnity itself. These books are designed to be of assistance to those interested in fire insurance inspection work, and the publishers bespeak for Volume Five the same cordial reception which has been accorded its forerunners, and thank those who have contributed to its pages.

CONTENTS OF PRECEDING VOLUMES:

No. 1. Cotton Mills, Clothing Factories, Soap Factories, Metal Workers, Paint and Varnish Factories, Brickyards, Patent and Enameled Leather Risks, Candy Factories, Breweries, Fur Industry, Storage Warehouses, Theatres, The Tobacco Industry.

No. 2. Tobacco Industry (continued), Flour Mills, Cabinet Factories, Garages, Fireproof Buildings, Sugar Refineries, Paper Mills, Hotels, Hat Factories, Printing and Allied Trades.

No. 3. Tanneries and Leather Manufacturing (illustrated). Woolen Mills, Shoe Factories, Rubber Manufacture (illustrated). Celluloid Manufacture, The Automobile as a Fire Hazard. Laundries, Oils, Fats and Fires, Wood Distillation, Forms from the Company's Standpoint, Forms from the Broker's Standpoint, Organization of an Insurance Company.

No. 4. Paper Box Factories (illustrated). Storage of Newspaper Stock. Oils and Volatile Solvents, Paint Factories (illustrated). Grease, Oil, Paint and Tar Fires, Paint Industry, Rubber Reclaiming Industry (illustrated). Woodworking Plants, Toy Manufacture (illustrated). Cooperage Industry (illustrated). Celluloid Dangers, Iron Galvanizing Plants, Electrical Hazards, Electric Car Houses (illustrated). Dry Goods Stores, Sprinkler Efficiency, Use and Occupancy Insurance (two articles). Ladies' Collar Supporters.

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LIQUORS AND LIQUOR RISKS.

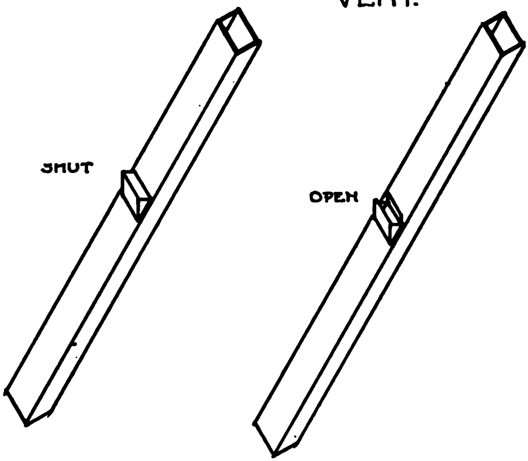
Review of the Various Hazards of the Manufacture, Handling and Distribution of Liquors—Suggestions and Recommendations.

By William J. Tallamy, Inspector, New York.

This very broad subject is necessarily of great importance to the fire insurance underwriter.

Owing to its magnitude I shall only attempt to cover such detail as may be of special interest, making brief references to

PART OF ELEVATOR LEG SHOWING VENT.



structural and other conditions as met with in the various classes of risks as they are considered.

AS TO PROCESS OF MANUFACTURE,

liquors may be properly divided into three classes, namely:

(1) The raw or uncooked—those made by a cold process, such as wines, champagnes, etc.

(2) The cooked—those subjected to a cooking or boiling

process during their manufacture, such as beer, ales, etc.

(3) The distilled—those subjected to such an intense heat during a cooking process that they are reduced to a vapor and recondensed into a liquid, such as whiskies, brandies, etc.

Of the three, those made in part by a process of distillation are the most valuable, in addition to being the more hazardous in handling inasmuch as they contain a larger percentage of alcohol.

All liquors undergo what is known as a process of fermentation sometime during their manufacture, that is the substance being used, usually a grain, fruit or similar mash, is subjected to a natural decomposition during which the saccharine matter in the mass is converted largely into alcohol and carbonic acid, the latter being promptly expelled in the form of carbonic acid gas while the alcohol is largely absorbed by the liquor.

LIQUORS PRODUCED BY THE COLD OR RAW PROCESS are made from fruit in a very simple manner. The fruit is crushed and placed in large vats where fermentation takes place almost immediately, due to the presence of a large percentage of saccharine matter.

In the manufacture of cider and white wines the fruit juice is extracted from the mass of crushed fruit before fermentation begins. Colored and other special wines are made from the fermented mass of crushed fruits, husks, seeds, etc.

When fermentation is complete the liquor is drawn off and placed in vats subject to an even temperature, where it is allowed to age. Champagne and other effervescent wines are usually bottled before fermentation is complete, so that part of the carbonic acid is retained in the wine.

The percentage of alcohol in wine is usually 8 to 12 per cent., rarely exceeding 25 per cent. There is little or no danger of explosive vapors being liberated by wine, either during the manufacture or in the subsequent handling, mixing, blending, etc. Wine-making in itself, therefore, does not constitute any great hazard. It is usually conducted in ordinarily constructed frame and occasionally brick buildings, frequently isolated in outlying districts, with no public and little private fire protection. Many wine manufacturing plants also produce wine distillates, such as brandies; in which case the hazard is seriously increased, as will be shown later on when the hazards of the distillery are considered in detail.

BREWERIES.

The products of breweries—ales, beer, etc., are referred to as being subjected to a cooking process during their manufacture, though cooking is only one of the many processes employed in breweries.

In construction the brewery plant usually consists of a group

of ordinary to superior constructed buildings, one to several stories in height, with basement and sub-basement in part. These buildings adjoin and communicate and are known as the malt house (malt storage and growing), malt dry house, mill building, brew house, beer cellars and refrigerator buildings, stable building, storage and shipping buildings, boiler and engine houses, pipe, machine and cabinet shops, cooperage and pitching sheds, etc. It is possible and very desirable to have the brewery plant cut up into several fire sections by having the openings between buildings provided with double standard automatic fire doors. This is seldom done, however, many of the doors in breweries being of the ordinary refrigerator type of door or the openings left unprotected entirely.

In local breweries, barley malt is largely used as a base. Malt is the common term applied to grain that has been germinated and dried by a forced unnatural means.

A SIMPLE METHOD OF CONVERTING GRAIN INTO MALT

is as follows: The grain is steeped in water for several days, either by immersion in vats or by a spraying process. The water is then drained off and the damp grain piled on the floor of a dry room for several days, during which time the grain in the interior of the pile begins to sprout and is turned to the outer surface. This continues until the entire pile has sprouted uniformly, which usually takes about ten days.

The sprouted or green grain is then subjected to a quick drying at a temperature of about 150° Fahr. There is no great danger in the malt growing, but the drying hazard is important, especially because of the accumulation of dust and chaff which usually collects in the dry house. In brewery plants the dry house is usually several stories high, the floors above the first being perforated metal on iron supports. As direct heat is necessary to give the malt the proper flavor, one or more kilns, usually brick set, are installed on the first floor. The grain is placed on the perforated metal floors above, where it is subjected to hand or power agitation to insure a uniform drying. In some plants it is moved from floor to floor of the dry house as drying proceeds, the first drying being done on the floor nearest the kilns, after which the malt is moved to the various floors above. In modern malting establishments, however, malt drying is frequently confined to one floor, the kilns, usually coal heated, being on the floor below.

The dry house should be constructed of fireproof material throughout, and detached or at least cut off from balance of plant by parapet brick fire walls. No open lights should be allowed in the dry house. After drying the malt is ready for the brewery.

At the present time the malting hazards are frequently conducted away from the brewery premises, the grain being received at the brewery in a malted state. As it is received, usually in bags, it is placed in storage bins in the mill buildings. Malt bins should be built of fireproof material, though many wood bins are now in use.

THE MILL BUILDING OF A BREWERY PLANT

should be constructed of fireproof material and should always be cut off from balance of plant by brick walls, all openings in same to be provided with double automatic 3-ply lock jointed metal clad fire doors or traps. It is here that the most important hazards of the modern brewery are housed. The floors of the mill building are usually pierced by a number of small chutes and worm or chain elevator enclosures or legs through which the malt is conveyed to the various machines on the several floors. The process here is in a sense automatic and continuous.

These enclosures or chutes should always be in an upright or slanting position so as to render them self-cleaning and should invariably be of fireproof material. Those used in conveying the grain after it has passed through the mill should be provided with explosion vents (automatic self-closing traps), which, in the event of an explosion in the enclosure, acts as a vent through which the force of the explosion is spent, thereby preventing serious damage to the elevator legs and the mill itself.

The non-fireproof elevator legs or enclosures beyond the mill should be provided with a steam jet opening into their interior, controlled by a valve held shut by a string which passes through the leg. With this arrangement, a fire in the elevator leg would burn the string which would automatically open the valve and flood the leg with steam, smothering the fire.

The malt is taken from the storage bins as needed and run through a cleaner, usually a revolving wood or iron enclosed screen. Here the foreign matter, chaff and dust, are removed, the dust and chaff being blown to a bin (which should be fireproof or at least metal lined, if wood, and vented to the outside of building). The heavier foreign matter is thrown aside, usually caught in bags or other receptacles. The dust hazard here is very important and open lights should be prohibited.

From the cleaner the grain is run into a hopper which feeds a weighing machine or automatic scale, by which the amount of malt to be used in each brew is definitely controlled. After leaving the weighing machine the grain is run into the mill hopper, which automatically feeds the mill.

THE MILLING PROCESS

is considered the most hazardous of any employed in breweries—

the great danger being from dust explosions, and the possibility of subsequent fire.

There are various kinds of mills in use in breweries, but practically all are roller mills. A roller mill consists of two steel rollers with rough surface set horizontally close together in a parallel position. These rollers are enclosed in a wood or iron case usually provided with small thick glass windows. The malt in passing between the steel rollers is crushed and reduced to a coarse meal, incidentally producing a fine highly explosive dust with which the mill enclosure is constantly filled while in operation.

In the handling of grain certain particles of metal or other minerals are taken up, some of which are too small to be removed by a cleaning process. These particles passing through the mill are almost sure to cause a spark which, if liberated in the dust filled mill enclosure, would probably result in an explosion. To guard against this danger many precautionary measures have been taken.

Inside the mill enclosure at the top, just above the rollers, a set of magnets are installed, in such a position that the malt must pass over their surface before it can come in contact with the mill rollers. These magnets are designed to attract particles of metal that might be mixed with the malt, and thereby prevent their coming in contact with the rollers. Some magnets are so arranged as to throw such particles of metal aside, while others hold the metal until it is removed by hand.

THE CONSTRUCTION OF THE MILL

below the rollers should be such as will automatically bank the ground malt up under the rollers in a way that would have a tendency to smother a spark should one be produced.

A simple arrangement frequently used consists of a hinged wood flapper hung below the rollers in such a manner that the ground grain accumulates against it until there is sufficient in weight to force the flapper open, allowing a small amount of the meal to pass through the opening at a time. With this arrangement the accumulation of the meal below the rollers would have a tendency to smother a spark, should one be produced. If, on the other hand, an explosion occurs, the flappers promptly yielding to the slightest compression, provides a ready exit to the fireproof elevator legs which are provided with automatic explosion vents through which the force of the explosion is quickly spent.

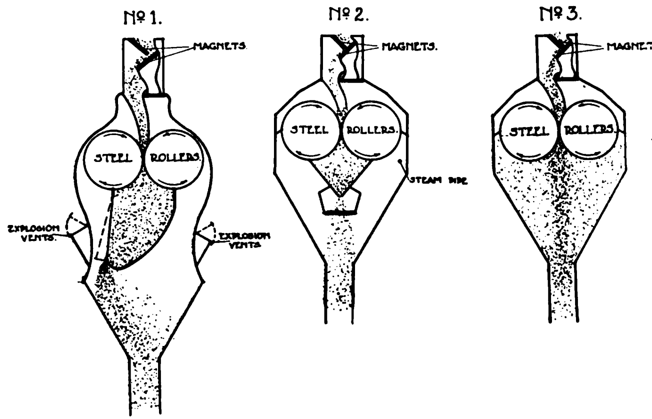
Another and more modern arrangement, is one in which the flappers below the rollers are held in place by a spring. This is a better arrangement than the one above described inasmuch as the spring, while providing a ready means of exit for the

force of an explosion, also promptly pulls the flappers back into place, having a tendency to check the draught and smother any fire that might start.

These two arrangements are installed in the so-called old style wood and glass mill.

As there is a possibility of fire in the mill resulting from explosion, the mill enclosure itself being inflammable, a steam jet should be inserted into all such mill enclosures, the valve controlling the steam supply, being automatically opened by the burning of a string which is also inside of the mill enclosure; an arrangement similar to that previously referred to as being provided for inflammable elevator legs

The following are sectional views of three malt mills in common use, showing the position of the magnets, the rollers, the banking arrangements and the location of steam jets, explosion vents, etc.



(1) Best Type of Mill. As This Mill Is Entirely Fireproof no Steam Jet Is Needed. Explosion Vents Are Provided Instead. (2) Wood or Glass Enclosed Mill With Wood Flapper. Meal Banking Arrangement Below Rollers Held in Place by Springs. See Steam Jet. (3) Wood and Glass Enclosed Mill With Magnet. Dangerous Because no Meal Banking Arrangement or Steam Jet. An Explosion Would Result Seriously.

These precautionary measures have been the means of so reducing the milling hazard in breweries that little fear is now entertained of trouble from this source.

THE BEST MALT MILL ARRANGEMENT

that I know of is the Schoch Mill. This mill is practically fireproof, the enclosure and the interior working parts being made of steel and heavy glass. The meal banking arrangement in this mill is especially good; not only is the ground meal retained in a receiver under the rollers, but it is kept there until the flapper is forced open by the pressure of the confined meal induced by the rollers themselves. It is estimated that the pressure necessary to open the relief flapper when the mill is in action is between 15 and 20 pounds.

THE GROUND MEAL BINS

which receive the meal after it leaves the mill should be fireproof and vented to outside of building. They are often located on the upper floors of brew house sometimes extending through floors. In many breweries a small amount of corn or other grain meal is added to the ground malt after which the mixture is ready for the brewing or cooking process.

It is infused with warm water and put through a mixing process sometimes in a horizontal spindle mixer which empties into a large vat known as the mash tub where the mixing is continued by the aid of a power agitator. After being thoroughly mixed the mash is allowed to stand three or four hours. It is in the mash tub that the diastase in the malt converts the starchy mixture into a fermentable mass.

The liquid part of this mass consisting of the water and the soluble part of the meal commonly known as wort is drained off placed in a large copper kettle known as the beer kettle to which is added a certain amount of hops—which give the flavor to the product.

THE SPENT GRAIN

is usually shipped away from the premises in a wet state as it is taken from the mash tub. In former years spent grain was frequently dried on the brewery premises. This drying constituted an important hazard, direct heated kilns being sometimes used in a similar manner to that formerly used in malt drying. At the present time the spent grain is seldom dried on the brewery premises. Where drying is done a steam heated revolving metal drier is usually used. As a low temperature only is required, the hazard is not a dangerous one.

The wort and hops are boiled together in a beer kettle for some time after which the liquid is separated from the refuse, cooled by running over cooled brine or ammonia pipes or through

water cooled jacketed pipes and run into open wood fermenting vats where yeast is added and fermentation takes place for about one week converting the saccharine matter in the liquid into alcohol and carbonic acid gas; the yeast that has been added segregates to the top of the vats in ale and at the bottom in lager breweries and is removed. The liquor is then run into large sealed wood vats in a cooled room known as a beer cellar or refrigerator where some dry hops and wood chips are sometimes added for flavoring and clarifying purposes and kept under a low pressure for about a month.

Here the liquor ages and passes through a sort of secondary fermentation, after which the product is ready for the consumer. After the ground grain leaves the hopper and is infused with water in the mixer, the direct hazards in the manufacturing processes are not important. The storage and fermenting cellars are usually very damp. There are, however,

IMPORTANT INCIDENTAL HAZARDS

in connection with practically all breweries, such as pipe fitting and machine repair, cabinet, carpenter and blacksmith shops, wagon sheds, stables and garages. The boiler house and engine rooms, which usually contain private electric plant, engines, pumps and ice machines, should be of fireproof construction and cut oft from balance of plant by heavy brick walls with double standard automatic fire doors at openings, if any.

Frequently vacant parts of breweries are used for storage of old saloon fixtures that have been taken through foreclosure proceedings from various saloons by the breweries. Where fixtures are stored the premises often become untidy and occasionally fixture repairs are made.

Beer barrels are coated inside with pitch to prevent any action on the wood by the beer. The method of heating and applying the pitch is important and should be carefully looked after. Pitching should never be done inside of brewery buildings. Barrel painting, recoopering and branding are also incidental hazards of importance. Paint and thinner should be properly handled and kept and used in a separate fireproof building. Method of heating branding irons should be carefully watched; in cooper shops care and cleanliness are the important features.

Another important incidental hazard is in the drying and revarnishing of the storage and fermenting vats usually done once a year. Sometimes portable fire pots are used in drying. This is a bad practice—steam or electric heaters should be substituted. Varnish should be brought inside of buildings as needed, the supply to be kept in fireproof vault, or a detached building used exclusively for storage of such material and supplies.

is an extensive and important feature. It is a necessary adjunct insomuch as the temperature in the fermenting and storage buildings, which comprise a large part of the plant, must be kept considerably below normal. The direct fire hazards in refrigeration plants when properly installed are not serious.

In ammonia systems the formation of explosive and inflammable gases is possible by the action of ammonia on the lubricating oil that finds its way into the system. This danger is minimized by the presence of oil traps in the engine room, usually near the ice machine and by relief valves usually placed at the top of the direct expansion piping. Care should be taken that no open lights are near these relief valves or near the glass gauge at the oil trap in the engine room, where there is any. Glass gauges are not used on all systems. Direct expansion ammonia refrigeration is less desirable than the brine system because it necessitates the presence of ammonia pipes in all of the buildings, subjected to refrigeration as well as many others through which it may be necessary to run the piping. In the event of fire in a building containing ammonia pipes, there is a constant fear that the piping may be broken, which means that the fire fighters are seriously hampered in their work of extinguishing the fire.

Carbonic acid gas refrigeration is considered more desirable for use in breweries than the ammonia system from nearly all points of view. It is not dangerous to life or property and would act as a fire extinguisher if released by a break in the piping caused by fire. This system is somewhat new in the East though there are many such plants in and around Chicago.

In breweries as well as other plants in which refrigeration is a part of the process, there is a great danger of a consequential damage. For instance, a small fire in the engine room might put the ice machine out of commission, and thereby cripple the entire refrigeration system, causing a heavy stock damage in a part of the premises where no fire occurred. For this reason it is desirable to have each cooled room piped separately with proper accessibly located gate valves controlling same. Refrigeration pipes should be run under ground, if possible, and should enter the building to be cooled in the basement or at the lowest floor.

DISTILLERIES.

Briefly stated, distillation is a process of separating the lighter, and usually more volatile, parts of a substance from the heavier parts by vaporizing same in a heated retort commonly known as a still, and recondensing the vapor into a liquid by subjecting it to a sudden cooling. This is usually done by conducting the

vapor through what is known as a worm—a coil of piping immersed in cold water. It is in the distillery that the so called high proof liquors, such as whiskey, brandies, etc., are made. Alcohol, cologne spirits, fusel oil and other alcohol by-products are also produced in distilleries. With the exception of brandies, most of the high proof liquors are made from grain, though alcohol itself can be and is made from various fruit and vegetable growths containing more or less saccharine matter.

Brandies are properly made by distilling fermented fruit juices, though whiskey compounds are frequently substituted for and sold as brandy.

The initial hazards and processes in the grain distillery, such as grain handling and storage, malting, cleaning and milling, are similar to those found in the brewery. The malting hazard is rarely conducted on the distillery premises; in fact some distilleries do not use malt at all.

Most American distilleries use rye, barley or corn meal as a base, adding a small amount of malted grain to induce a more extensive fermentation. The refrigeration hazard is generally eliminated. Throughout the preliminary processes the dust hazard is most important, and similar precautionary measures to those found in the modern brewery should always be taken.

As the initial hazards of the distillery closely resemble those of the brewery, which have been considered at length, I will not dwell further on them at this time, but will review some of the

CONDITIONS IN THE DISTILLERY PROPER.

After the grain has been reduced to a meal it is infused with water, and run into what is known as the cooker, usually cylindrical iron tanks placed horizontally on a suitable base of masonry, and heated usually by steam. Here the mash is cooked at a high temperature from five to fifteen minutes. The temperature is then suddenly reduced to prevent premature fermentation, and the mash run into large wooden vats known as the fermenting vats where yeast is added and fermentation proceeds for three or four days. The fermenting vats are then drained into iron or wood receivers from which the mash is pumped into the so-called beer still—a large covered (usually copper), but sometimes wood receptacle. At the top of this receptacle is a small opening to which is attached a hollow copper tube usually 6 to 10 feet in length, gradually tapering from 8 to 12 inches in diameter at the top of the still to about two inches in diameter at the other end, which is connected with a worm (a spiral copper coil immersed in cold water). The still is usually heated by fire underneath or steam coils inside, or a steam jacket.

The mash is boiled until practically all the liquor is vaporized and recondensed in the worm. The products of this distillation

are commonly known as high wines. There are many kinds of beer stills in use; the only important distinction being in the method of heating. A direct heated still of course is more to be feared than one heated by steam. Coal, coke, wood, fuel oil and gas are frequently used for fuel in the former. Great care should be exercised in the proper setting of the furnace. Most direct heated stills are brick set, that is, the fire box and lower half of the still are enclosed by brick laid in cement mortar on a brick base. The best results, however, are met with when steam heat is used, because of the uniformity of the heat.

The liquid produced by the first distillation is placed into another still, where it is again vaporized. This vapor is conducted through a column—a vertical, cylindrical shaped separator containing several cells in each of which is an inverted disc so arranged that when the still is in operation some of the vapors in passing through the cells are condensed, immersing the lower edge of the disc and forming a seal. A certain grade of spirits is condensed and retained in each of the cells in the column, while the highest proof spirit vapor finds its way through all of the cells, and is finally condensed in the worm. Some of the cells are connected back to the still by pipes, through which the overflow returns to the still for further distillation. Other cells are connected by pipes to leaches or rectifiers, receptacles containing pulverized charcoal, through which the liquor percolates or is forced for cleaning or filtering purposes. The liquors are then ready for official government test which is usually made in the so-called cistern room, which is under constant Federal supervision.

THE ABOVE IS ONLY ONE OF THE MANY METHODS

employed in distilleries. Nearly all stills differ in construction. Most American stills have traps or boxes with glass sides or tops which enable the operator to keep in close touch with what the still is producing. One such box is known as the tail box, and is usually located between the condenser and the percolator. Another is known as the rectifier box, receiving the liquors as they leave the rectifier or percolator. Here official distillery tests are made. Some distilleries pursue a continuous process of distillation. In this case the fermented mash is placed in an elevated tank which automatically feeds the still through the system of piping, columns and separators conducting the vapors from the still. The action of the hot vapor on the mash, and the mash on the vapor is such as to eliminate the necessity of the first distillation, described herein as being performed in the beer still.

After proper tests are made in the cistern room by the Government, the various liquors are run into charred barrels and

placed in cellars or aging rooms, where they remain until removed to the various distributing agencies.

In the manufacture of alcohol, cologne spirits, fusel oil and other alcohol by-products, sometimes referred to as low wines, a similar process of distillation is continued. Throughout the distillery proper, open lights should be avoided owing to the large percentage of alcohol necessarily present, and the possibility of leaks in the still piping or other parts of the equipment emitting explosive vapors. For commercial reasons leaks in the still and its parts are carefully looked after and usually avoided.

INCIDENTAL HAZARDS IN THE DISTILLERY

are similar to those of the brewery. Charred vats are used in aging for flavoring and clarifying purposes. The method of charring the vats should be carefully looked after. Frequently portable coal fire pots are set inside of the vats, the heat from the fire charring the interior wood surface. This should be done in a separate fireproof building or outside of distillery buildings entirely. Alcohol and cologne spirits barrels are coated with glue on the inside to prevent the action of the alcohol on the wood. Liquor barrels are also coated at times when the contents are to be removed within a limited time. The method of heating the glue should be looked into. Coopering and recoopering are usually done on a small scale. Care and cleanliness are an important feature here.

Branding is an incidental hazard, the method of heating the iron should be looked into.

Barrel painting and varnishing hazards are important; gasoline, benzine, turpentine, paints and varnish are used at times. The supply should be kept in a fireproof vault, or in a detached shed or building. The amount inside of shipping building to be limited to one day's supply, and where explosives, such as benzine or gasoline are used, safety cans should be provided.

In the manufacturing of cheap whiskey a method of forced aging is usually adopted. This is done by inserting a steam coil in the barrel, which heats the liquor and hurries its action on the charred wood.

In construction, distilleries are usually ordinarily constructed buildings forming one fire risk. They are frequently isolated with limited or no public fire protection.

After the wines and distillery products have sufficiently aged. they are shipped in barrels to the various distributing depots. Most of these depots hold what is known as a rectifier's license, which amounts to a Government permit to remove the revenue stamp and change the quality of the liquor to suit the requirements of the trade. Such establishments are known as rectifiers.

is entirely a cold process, by which the proof of the liquor (percentage of alcohol contained therein) is raised or lowered by the addition of alcohol or water as may be necessary. As a rule liquors of 88 to 90 proof are required for commercial purposes, while the liquors in leaving the distillery are usually of a much higher proof, frequently 125 to 135 proof. It becomes necessary, therefore, to more frequently lower rather than raise the proof of the liquors, which means adding of water and necessarily reducing the hazard.

When the liquors are received by the rectifier, they are tested and "dumped" or run into a vat or tank, to which is added water or alcohol as may be necessary. Occasionally flavoring syrups are also added and at times the liquors themselves are mixed in order to produce a certain blend. When mixing is done, however, the process is known as compounding; the word rectifying being properly applied to the action of reducing or increasing the proof of the liquor by a cold process as before described.

Rectifying is practically done under Government supervision; all liquors received and shipped by the rectifier being inspected by a Government representative who attaches a revenue stamp. While the process of rectifying is in itself not a hazardous one, there are several important hazards incidental thereto. For instance, the flavor of liquors is often changed by a process of distilling, the liquor being placed in a copper still together with several flavoring herbs or berries. During the subsequent boiling or redistilling the action of the heated liquor on the immersed flavoring ingredients causes a certain amount of flavor to be absorbed by the liquor as it is converted into vapor to be recondensed in the worm, usually an iron spiral coil immersed in running cold water. The still used for this purpose is similar to the one described as the beer still in the distillery and consists of a covered copper kettle heated by direct heat underneath.

At the middle of the top or cover is an opening 6 to 10 inches in diameter, to which is riveted a horizontal copper tube 6 to 10 feet long and tapering from 6 to 10 inches in diameter at the mouth to about one-half inch in diameter at a point where it enters a coil of iron or copper pipe, spiral shaped and immersed in cold (running) water, where condensation takes place, the outlet at the bottom of the coil being connected to the barrel or vat into which the liquor is to be placed by a rubber hose or pipe.

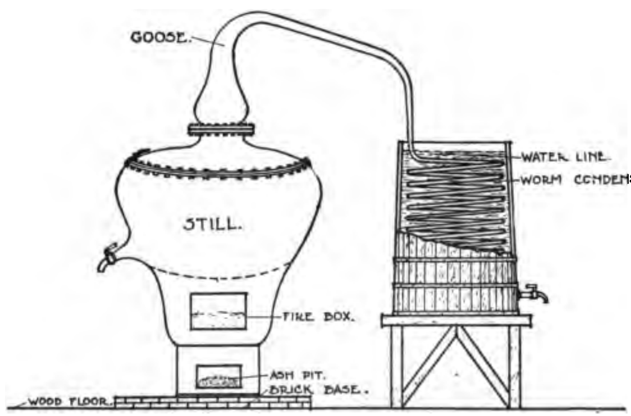
The kettle in this case is known as the still; the copper tube, the goose, and the condensing coil, the worm. (See Sketch No. 5.)

THE MANNER OF HEATING THE STILL

is, of course, the important point in this process. While steam heat gives the best results owing to its uniformity, direct heat is usually used in New York City, frequently gas, coke, wood and occasionally coal being used as fuel. When coal, coke and wood fires are used the setting of the still should be as follows:

The still should, if possible, rest on floor constructed entirely of non-inflammable material, but, if the floor is of wood, it should be covered with two courses of brick well laid in cement mortar on sheet iron, same to extend out at least 2 feet all sides of still. The still itself should be set on heavy sheet iron supported by lines of brick on flat sides resting on the two courses of brick and cement, insuring at least a 2-inch air space between ash pit below firebox and the brick and cement floor covering.

SKETCH—No. 5.



If gas heat is used, one course of brick well laid in cement mortar over metal covered floor is considered reasonably safe. There is, of course, the possible danger of leakage in the still or goose emitting explosive vapors. It is, therefore, advisable that there be no open lights near the still. This danger is considered very remote owing to the construction of the still and the care it receives when in operation.

ANOTHER IMPORTANT DANGER IN RECTIFIERS

is the handling of alcohol. The supply should be limited and kept off the working floors when not being used. There is some danger of explosion of vapors in empty or partially empty barrels that have contained alcohol and high proof spirits, a certain amount of the liquor left in the barrels being vaporized and ignited by careless handling of artificial light.

Barrel painting, varnishing and recoopering are incidental hazards of a rectifier, oils, varnish, benzine, turpentine and paint being handled and used in nearly all cases.

Other incidental processes in many rectifying plants are filtering, percolating and purifying processes during which the liquor is allowed to percolate or trickle through a receptacle containing asbestos or ground charcoal. There is nothing dangerous about this process.

Occasionally flavoring extracts and syrups are made on the premises, which, of course, brings into play another necessity for artificial heating. Usually gas or steam heated kettles are used, and occasionally a confectioner's stove, the setting of which should be carefully looked after.

Stenciling and branding are also done to some extent. Non-inflammable stenciling material should always be used with water as a thinner. In branding, attention should be given to the method of heating and manner of handling the branding irons.

AFTER LEAVING THE RECTIFIER

the liquors are handled by wholesale wine and liquor dealers. Here the hazards are usually mild—cold mixing and blending are often done, and occasionally alcohol is added to wine for preserving purposes. No rectifying is permitted here. Many wine merchants put up a so-called rectified wine to appeal to a certain kind of trade, but in reality the process applied is not rectifying, but simply a blending (mixing two or more qualities of wine) or putting wine through a percolating or filtering process. Alcohol is never added in legitimate establishments except when the wine contains too little alcohol to preserve it a necessary length of time. Barrel painting and varnishing and occasionally recoopering hazards are also incidental hazards here.

In addition, the bottling and occasionally compounding (making cordial and other such special drinks) by a cold mixing and filtering process, are done here involving no great hazard. Incidental to the bottling hazard we find the necessity for heating water for washing purposes; the handling of straw wrappers, saw dust, excelsior, paper clippings and other packing materials, shook storage and case making, all of which are self-explanatory

and should be carefully looked after. Stenciling and branding hazards are also found here.

The stock is usually kept in large vats, barrels and bottles. When large vats are on floors above basement, attention should be given to the floor supports as the concentrated weight caused by the liquor in the vat might easily result in overloading a floor. Many so-called wholesale wine and liquor establishments confine their stock to wines and brandies, while others handle all kinds of liquors and little wines. The latter, of course, forms the more hazardous risk. Next come the so-called

WHOLESALE AND RETAIL LIQUOR STORES,

with and without bars. Here the hazard is practically that of retailing and occasionally a little bottling. Stock here is kept in barrels and bottles, but usually sold in bottles, except where there is a bar. In this case the nature of the establishment is more like that of the ordinary saloon.

The saloon and café need little mention. The slight distinction between these two establishments might be said to be the cooking or kitchen hazard.

Indeed there is more or less cooking done in connection with nearly all such establishments, but as a rule the café makes more of a pretense at furnishing meals and, therefore, employs more extensive cooking equipment. As a rule the equipment in the café is less hazardous inasmuch as a special provision has usually been made for this department, while with the saloon the cooking arrangements are little thought of or provided for till the place is opened for business and then the stove, usually a coal or gas range, is put in some unused, generally dark and more or less unsuitable and inaccessible corner, usually in the basement where the stove is frequently left burning for hours at a time with no attendant in charge. Location, neighborhood, class of trade, care, management and cleanliness especially as to the basements of these establishments are important features that should be given consideration, when retail liquor risks are under investigation.

BUTTON FACTORIES.

General Review of the Various Hazards, Processes and Methods of Manufacture Commonly Found in Risks of This Class.

By William J. Tallamy, Insurance Inspector, New York.

Button factories so widely differ in their equipment, machinery employed, process of manufacture and class of hazards involved that it would be inadvisable to attempt to consider them as a class.

For instance, many factories might justly be treated as non-hazardous risks inasmuch as no serious hazards are employed in the manufacturing process, and the stock itself is non-inflammable.

On the other hand some button factories involve very serious hazards throughout. Unfortunately in many cases the dangers are palpably little understood or guarded against.

Button factories of this class are unquestionably responsible for the lamentably disastrous fires that cause almost instantaneous loss of life and property, and put button factories as a class on a prohibitive basis with many fire insurance companies.

Take, for example, the recent fire at No. 141 West Twentieth street, New York City, in which three lives were lost.

The writer visited this factory a few weeks before the fire occurred and found the floors, machine tables and benches strewn with celluloid stock, clippings and shavings. The floor on which the fire started was equipped with numerous button presses, many of which were heated by gas, the flame being in contact with the die on the press, about an inch and a half above the table on which the celluloid stock rested.

As will be remembered the fire in question started as the factory was opening for the day, and spread so rapidly that all evidence of its origin was quickly destroyed. Many theories have been advanced regarding the cause of this fire; but I am firmly convinced that it must have been started by accident when the employee in lighting the gas flame at the presses possibly ignited some celluloid stock on the bench, or perhaps threw the burning match on the floor where some celluloid clippings were scattered about.

The quick spreading of the fire is explained by the probable presence of celluloid stock and refuse.

button factories are ordinary. In New York and other large cities they are usually housed in loft buildings, occupying one or more floors. In smaller towns and cities they usually form sole tenants in ordinary or mill constructed buildings.

The most hazardous button factories in operation at the present time are those in which celluloid buttons are made in whole or in part.

The machinery usually employed in a factory of this kind consists of numerous stamping and cutting machines, lathes, drills, turning and frazer machines, drop hammers, emery and buff wheels, hack saws, shapers, forges, annealing furnaces, gas blowpipes and button presses, the latter being partly heated by gas, electricity or steam at the dies and plates. The power is usually furnished by electric motors, gas or steam engines.

The processes used are coloring, japanning, cutting, pressing, stamping, turning, buffing, polishing, assembling, lacquering, packing and shipping.

The raw stock consists largely of metal in small sheets, cardboard, sheet celluloid, japans, varnishes, lacquers and thinners, etc.

Sheet celluloid is usually brought to the factory in sizes varying from 20 to 30 inches in width and 36 to 50 inches in length, the thickness usually being 10-1000 to 50-1000 of an inch. It should be kept in fireproof closets, the walls, top and bottom of which should be double sheet iron on angle iron frames, space between the double metal walls to be filled with 1 inch of asbestos. Doors should be of same construction as walls, with wrought iron catches and hinges. Uusually 50 to 500 sheets of celluloid are on hand at a time.

The japans, varnishes, lacquers and thinners are bought in ordinary cans containing one to ten gallons each. This stock should also be kept in a fireproof closet; the lacquers and thinners should be kept in and used from approved patent safety cans. The celluloid, lacquers, japans, varnishes and thinners should be kept in a fireproof detached building or vault when possible, as in out of town plants.

CELLULOID COLORING.

The coloring process is applied to celluloid usually when it is in sheet form. At times, however, celluloid buttons are colored after they are made up.

Though celluloid is made in a variety of colors, nearly all button factories do coloring and recoloring on their own premises.

The lacquers and varnishes used for this purpose, known by various trade names, are highly inflammable, and under certain

conditions explosive, being made usually of gun cotton or collodion wool dissolved in amyl acetate, and colored with mineral or aniline colors as desired. They are applied by an air brush or spray machine.

A spray machine is a portable affair consisting of a small glass or metal container or receptacle provided with an air tight screw

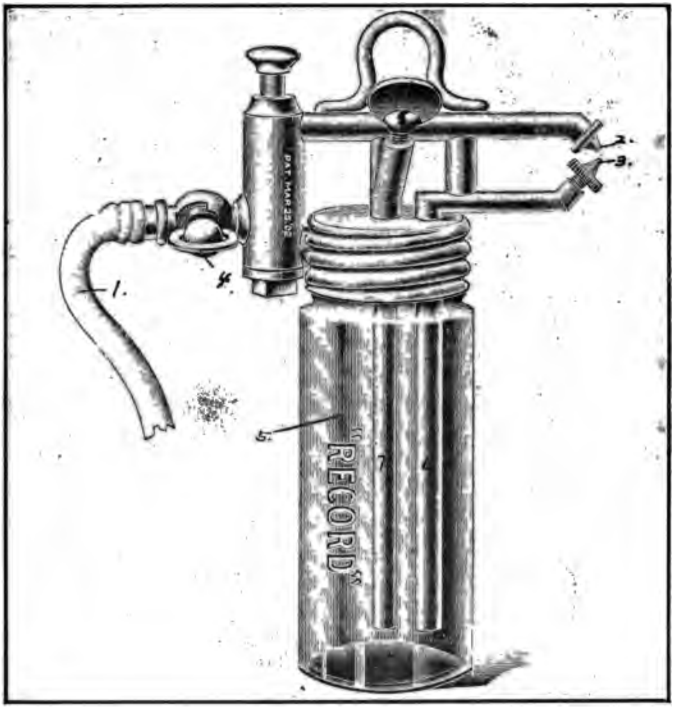


FIG. 1.—SPRAYING MACHINE OR AIR BRUSH.

(1) Rubber tube through which air supply passes; (2) air outlet; (3) outlet through which the force of air in passing over its orifice draws or sucks the liquid from the container, converting it into a fine spray; (4) valve controlling air supply; (5) glass or metal spraying solution container; (6) suction tube through which liquid passes to outlet; (7) tube through which air passes to the solution for agitation purposes; (8) valve controlling air for agitation purposes.

top. One small opening to the interior being through a tube projecting about one inch above at the side of the cover and extending inside to about one-half inch from the bottom of the container. Above, and fastened to the cover, is another metal tube which is connected to a flexible rubber air pipe or tube at one end and having an outlet at the other end just above and pointing beyond the opening in the first mentioned tube.

The air pipe is connected to an iron tank containing air under a pressure of 10 pounds to 150 pounds.

In operating the spray machine, the container is filled with the liquid solution to be used, and the material to be sprayed is spread out on a flat surface, usually a work-bench. The air on being released is forced over the opening in the tube which enters the container causing the liquid solution to be drawn out of the container through this tube to a contact with the rushing air by which it is promptly converted into a fine spray thoroughly coating the exposed surface of the stock.

Owing to the highly inflammable nature of the coloring solution, the air in the vicinity of the spray machine when in operation is usually saturated with very explosive vapors. It is therefore desirable that this work be done in a fireproof room or enclosure well ventilated to the outside of the building or provided with an exhaust fan of sufficient capacity to properly expel the explosive vapors outside of the building as they are liberated.

As a matter of fact, however, spraying is frequently done in the factory proper, while in some cases sash partitions only are installed between spraying department and main workroom.

In some establishments the newly colored celluloid is allowed to "air dry," being left exposed on open benches until the explosive moisture on the surface evaporate in the room. Other concerns dry the treated celluloid in a mildly heated dry room. Steam heat can and should be used in this drying. The dry room should be built of metal and asbestos and vented to outside of building or brick chimney. The frame work should be angle iron, and the walls, top, bottom and door should be of double heavy sheet metal with space between filled in with 1 inch of asebestos. The door hinges and catch should be heavy wrought iron, riveted through the walls and angle iron frame. The dry room should rest on two courses of brick and cement and all woodwork and other inflammable material should be kept at least two feet from same.

JAPANNING

(coating the metal stock with heavy enamel paint) also involves very severe hazards. In some plants the japanning is done while the metal is in sheet form, while in others it is done after the buttons are made.

In all cases a heavy, quick drying, highly inflammable enamel

paint is used, usually with a spray machine in a similar manner to that of celluloid coloring. Benzine, turpentine and explosive substitutes are used as thinners for the japan. As is the case with the celluloid coloring process, the air in the vicinity of the japan spray machine is filled with explosive vapors while the machine is in operation.

In nearly all cases japanned stock is subjected to artificial drying with direct heat, a dry heat being necessary.

Various kinds of japan ovens are in use, many being danger-

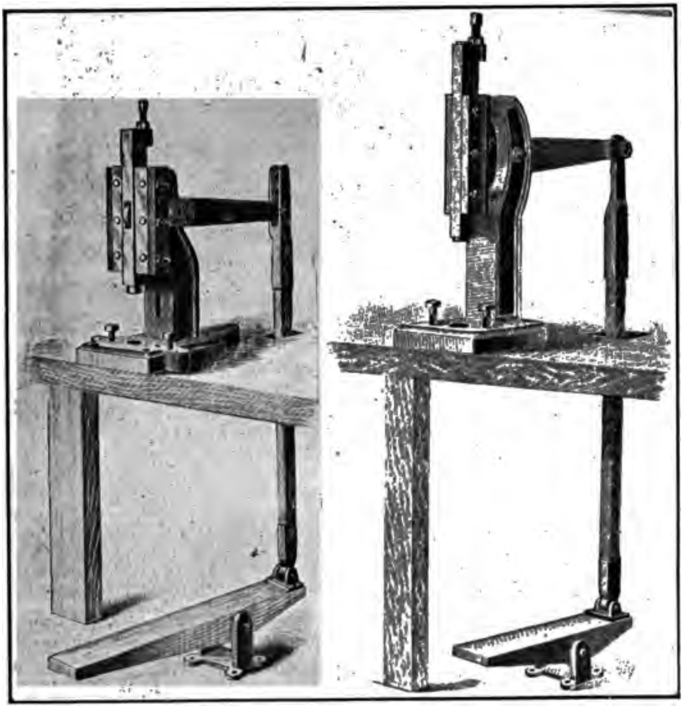


FIG. 2.—TREADLE CUTTING PRESS WITH WOOD TREADLE.

FIG. 3.—TREADLE CLOTH COVERED BUTTON PRESS.

ously unsafe. Where possible, as in outlying districts, japan drying should be done in separate fireproof buildings.

Where this is not possible and the japan dry oven is necessarily inside of main building it should be built of metal and asbestos in a similar manner to that recommended for drying colored celluloid. As direct heat is necessary, the flame should be so shielded that it will be impossible for it to come in direct contact with the explosive vapors ever present in japan dry ovens when in use. When coal fires are used, stoves should be fed from outside. Gas heat is very common in local factories.

No open lights should be permitted in rooms whose japanning or celluloid coloring is done.

The cutting, pressing, stamping, buffing, polishing, assembling, packing and shipping processes are simple and self-explained.

CELLULOID REFUSE.

The floor and machine tables in the vicinity of the celluloid cutting and stamping machines are often littered with celluloid clippings and chips. This is a very dangerous condition. All celluloid refuse should be cleaned up several times a day and placed in a riveted galvanized iron can with automatic closing flanged cover. The can should rest on iron legs at least six inches above the floor or be filled with water by which the clippings are immersed.

The presses on which celluloid buttons are made are always heated, as celluloid cannot be shaped or molded in a cold state. Gas heat is frequently used, an open flame being located just above the machine bench in contact with the steel die, another flame being below the plate or socket on which the celluloid is placed for working. It can therefore be readily seen that the celluloid and the gas flame are dangerously close together during operation.

Electricity and steam heat are used to some extent, but gas heat is more common in local factories and said to give better results.

Forges and annealing furnaces, if any are used in tool repairing, should be mounted on iron legs over properly protected floors, preferably covered with brick and cement. The forge should be provided with a metal hood vented to a brick chimney. Both should be set as far as possible from the spraying and celluloid working departments.

Brass and white metal parts are occasionally used instead of colored and black metal, in which case the japanning hazard is eliminated, and plating, buffing, polishing and lacquering hazards are substituted. The plating, buffing and polishing hazards are generally mild. Buff wheels should have automatic dust collectors discharging into a metal can through a cyclone separator and the dust can be kept free from accumulations of buff dust.

The lacquering hazard is important. A spray machine may be used, but owing to the small surface to be treated lacquer is usually applied by hand with a brush. The lacquer commonly used is a colorless, highly inflammable zaponic liquid, applied to prevent subsequent tarnishing.

Lacquered buttons are usually dried in an artificially heated dry closet. A metal and asbestos closet similar to the one recommended for use in drying japanned stock is desirable. Steam heat can be used with good result and should be insisted upon where available.

In some factories buttons are made of celluloid exclusively. The celluloid used is necessarily received in thicker sheets, usually $\frac{1}{32}$ to $\frac{1}{4}$ inch in thickness.

The hazards here are very severe. Not only do the presses on which the buttons are shaped require artificial heating, gas being usually used, but the stock itself is frequently worked on frazer, drilling, turning and sandpapering machines emitting quantities of celluloid waste in the form of chips, shavings, clippings and coarse dust, which during the operation of the machines are usually scattered about the floor and machines. Solid celluloid buttons are often made of two or more pieces. These are cemented together with celluloid cement thinned with amyl acetate. Recoloring is also done here to some extent with the accompanying hazards as previously described.

Combination metal and celluloid buttons are more popular however, a development of the past two years. The back and occasionally rim of the button is metal, while the front or centre is usually celluloid. At times paper fillers are used.

These buttons are likely to retain their popularity for some time because of their lightness, cheapness and the possibility of being made into almost any color and shape to match the varying styles of woman's garments on which they are used almost exclusively.

METAL BUTTONS.

Important special hazards are involved in factories where metal buttons are made exclusively.

Shops equipped for this branch of the button industry present more or less the appearance of a machine shop.

Arranged in tiers are various power machines similar to those frequently found in machine shops, including machinist's lathes, drills, stamping presses, drop hammers, hack and circular saws, cutting, shaping and milling machines, emery and buff wheels, forges and annealing furnaces. The stamping presses, however, greatly outnumber all other machines.

Sheet metal is used almost exclusively.

The japanning is occasionally done with a spray machine and hand brush while in sheet form as in the combination metal and

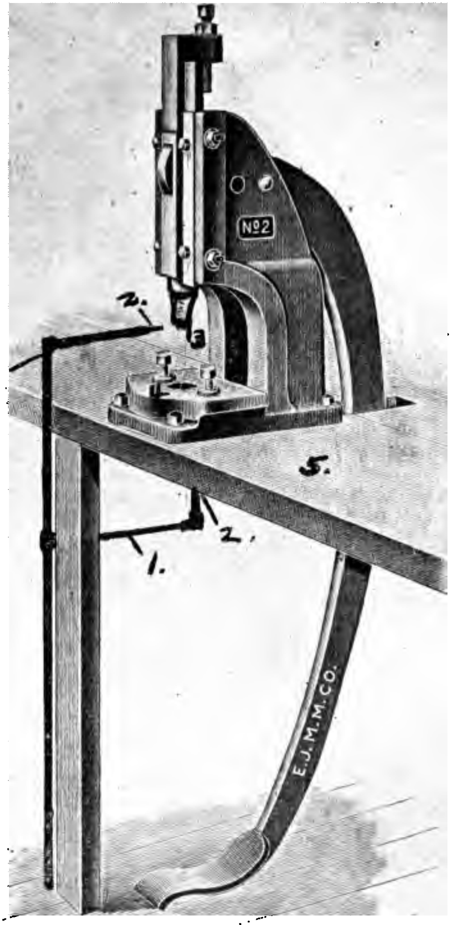


FIG. 4.—TREADLE BUTTON PRESS USED IN MAKING CELLULOID BUTTONS. DIE AND POCKET BEING GAS HEATED.

(1) Gas pipe connection; (2) gas burner; (3) gas heated die; (4) gas heated pocket or plate; (5) wood bench on which celluloid rests while being worked.

celluloid button factories. It is more frequently done after the buttons are made. This japanning is done in several ways.

Some factories use the spray machine. Others employ what is known as a dipping process. The japan is placed in a receptacle called a dip tank, usually a metal or metal-lined wood tub of five to ten gallons capacity.

The stock is placed in a metal screen, dipped in the japan solution and hung over a trough in a slanting position so arranged that the drip from the buttons and screen will fall in the trough and flow back to the dip tank.

In other establishments the stock and a necessary amount of japan are placed in a metal revolving drum or tumbler open at the top. During the subsequent agitation the buttons are thoroughly coated with the japan.

In all cases the japan hazard is severe, explosive or highly inflammable thinners being used as indicated in the previous chapter. It should therefore be conducted in a fireproof room. The subsequent drying is done in a similar manner to that previously described and like precautionary measures should be taken.

The cutting, stamping, pressing, spinning, tumbling, sorting, packing and shipping hazards are nominal, the processes being simple, as indicated.

Oily waste is common in the metal button shops and should be kept in riveted iron cans on iron legs six inches above the floor. The cans should be provided with self-closing covers, preferably with a metal upright on top, which prevents cover from opening more than one-third of the way and insuring its automatic closing.

Where brass and white metal buttons are made, such as uniform buttons, the japan hazard is eliminated. Plating, polishing, buffing and lacquering hazards are added, however, the method being similar to that in use in combination celluloid and metal button factories. This department is generally more extensive in plants of this kind, and the hazards involved are comparatively greater.

GLASS BUTTONS.

In glass button factories the hazards are severe and important, though the process is simple.

Where glass manufacturing is done the furnaces should be built of fire-brick in a fireproof detached building.

Most glass button factories, however, receive their glass in bar form, the proper color and thickness, the bars usually 3 to 4 feet in length. The subsequent process of manufacture consists of reheating, molding, cooling, packing and shipping.

The heating is done by gas blow pipes in a small especially constructed muffler furnace. The gas flames are small and

numerous, there being eight to twelve burners to each furnace half on opposite sides pointing toward the centre which is the meeting place of the flames and the point of contact with the glass bar inserted through an opening at the side of the furnace.

When the end of the glass bar is heated to a white heat and softens, it is wound around the end of a small steel bar, to which it readily adheres.

The soft glass is then placed in a horizontal screw press where the button is pressed into shape. The die in the press is kept hot by a small gas flame insuring a smooth surface to the button.

The buttons leave the press automatically, dropping into a metal trough, which leads to a fire-brick lined receptacle, usually heated by gas to prevent buttons from cooling too quickly and cracking. The heat is retained in this receptacle about six hours after the manufacturing of buttons has been discontinued, gradually disappearing. To prevent possible fire, it should be mounted on a brick and cement base.

The furnaces should be built of iron, fire-brick and clay on a fireproof base. The press should be entirely of metal.

The use of explosives is necessary in the manufacture of glass buttons.

The hazards, though severe, are readily provided for.

CLOTH COVERED BUTTONS

are usually made in small cheaply equipped shops, by hand, with the assistance of a few treadle and hand power machines.

Raw stock consists largely of tailor shop clippings, paper (card board), wood and metal parts (prepared away from the premises).

The shop clippings, usually kept in burlap bags until used, are cut by hand on a heavy wood cutting block, a steel die and wood mallet being used. Paper fillers are also cut in the same manner.

The cloth filler and wood and metal parts, if any, are then pressed together in a treadle press, and the button is made.

At times rough or frayed edges of the cloth are visible after the button is made. These are removed by a crude and somewhat hazardous singeing process. The buttons are placed in a metal wire screen, lightly saturated with alcohol and set on fire. During the burning of the alcohol, the screen and its contents are kept in rapid motion to prevent the buttons from catching fire or discoloring. The frayed ends are consumed with the alcohol which is generally allowed to burn itself out. This constitutes practically the only important incidental hazard met with in cloth button factories. The premises are generally untidy, and a cheap class of help is usually employed.

do not necessarily involve serious special hazard in their manufacture.

The machinery and equipment employed, processes and hazards are similar to those found in pearl button factories in a measure, as will be described to some extent later on.

Lathes, drills, turning machines, emery and polishing wheels predominate.

Explosive oils and chemicals are not generally necessary, and seldom used.

The dust and refuse here is not very abundant or inflammable.

The origin of bone and horn buttons is clearly indicated. Vegetable ivory buttons are made from a nut imported from South American countries.

COMPOSITION OR IMITATION RUBBER BUTTONS

are made of a composition of rosin, clay, pulverized rock and mineral colors, together with certain secret ingredients, said to be non-inflammable.

These substances are thoroughly mixed in a power agitated mixer, and run through a calender press usually steam heated at a low temperature.

The composition is taken from the calender machine in heavy sheet form and placed on metal steam tables where it is kept soft and in proper condition for the button presses. These presses are heavy steel affairs cooled by running water, so arranged near steam tables that the help can readily transfer the

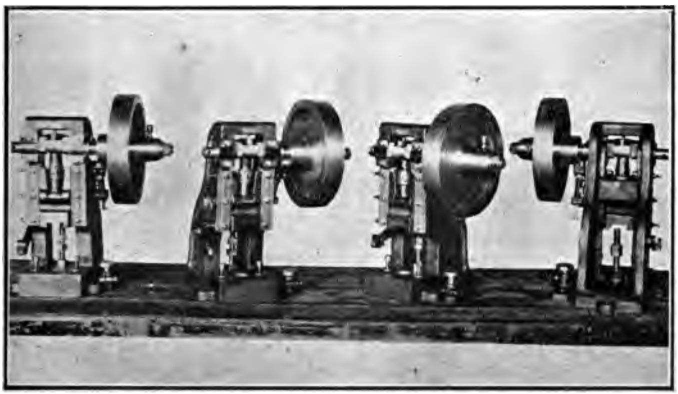


FIG. 5.—POWER STAMPING PRESSES.

composition from the steam table to the presses with little danger of premature cooling.

When the buttons leave the presses they are practically finished. The subsequent polishing, finishing, packing and shipping involving no great hazard.

No explosives are necessary in the manufacture of composition buttons. The incidental hazards are unimportant in properly equipped plants. The handling of quantities of rosin is necessary, however, and occasionally excelsior is used in packing.

These plants are usually located in small cities and towns where labor and land are cheap. Buildings are usually low, and frequently cut up into two or more fire sections. Boilers should be in separate building properly cut off from main building. Steam pipes and tables should be kept free from contact with woodwork.

PEARL BUTTONS

are made from large sea clam and snail shells, the white or mother-of-pearl buttons from shells imported from Australia, Japan and the Philippine Islands. The blue buttons are made from shells found largely along the coast of California.

The hazards involved in the manufacture of pearl buttons are mild. The machinery usually consisting of numerous cutters, turning, drilling and shaping lathes, grinding, emery and polishing machines.

The shells are received in their natural state, soaked in water for softening purposes and cut in strips by high speed steel circular saws, kept wet while in operation.

The shell strips are run through a special cutting machine provided with circular cutters, which produce cylindrical shaped pieces the necessary width of the buttons to be made.

In some factories the subsequent manufacturing is continuous and automatic, same being done in a special machine which receives the pieces at one end, discharging the finished buttons from the other end as they are made.

In other establishments the various cutting, grinding, turning and drilling operations are done on separate machines.

After the buttons are made, they are cleansed in a solution of dilute sulphuric and muriatic acids in a revolving earthenware tumbler. They are then placed in wood tumblers with sawdust, where they are dried and polished. After leaving the tumbler they are sorted and packed ready for shipment.

In the better grade pearl button factories where ornamental and high grade buttons are produced the manufacturing and finishing processes are conducted individually by hand with the use of various types of specially constructed machinery, such as turning, grinding, drilling, buffing and polishing machines.

In view of dust-producing tendency of pearl button machinery, many machines are provided with dust collectors similar to those in use in woodworking establishments. This does not affect the hazard, however, as pearl dust is non-inflammable.

In some factories the color of the stock is darkened by dipping same in a solution of nitrate of silver and aqua ammonia.

Where gas light is used, swinging brackets are common. Care should be taken to prevent them from coming in contact with or exposing woodwork.

Tool repairing is sometimes done on the premises introducing a light machine shop hazard.

The handling and use of sawdust is an objectionable feature. Sawdust should be limited in amount and kept in a fireproof vault or at least a metal-lined bin.

Hazards of Blind Attics.

By C. C. Dominge.

A very striking example emphasizing the hazard of open "cock lofts," sometimes called blind attics or roof space, presented itself on Thursday afternoon, May 29, 1913, when ten of the thirty frame dwellings in the row at 1312 to 1370 College avenue, New York City, suffered severe damage.

It appears that roofers were working on building No. 1358 and were using a gasoline torch for repairing. They left the job at noon and neglected to extinguish the torch. About forty minutes later fire was discovered near the point where the torch was left.

Owing to the presence of the open cock lofts from Nos. 1348 to 1370, the fire spread very rapidly to the north and south. By the time the firemen arrived the entire roof space was in flames and they were compelled to chop into this concealed space in order to fight the fire. A frame division wall checked the advance of the fire at No. 1346.

LESSONS TO BE LEARNED FROM THIS FIRE.

Inspectors reporting on frame rows should always ascertain if these concealed spaces exist.

All buildings having such concealed spaces should be stopped with incombustible material. The present New York City building code demands that in rows of two or more frame buildings their side walls shall be filled with some fireproofing material 4 inches thick from the basement to the bottoms of the roof boards.

VARNISH FACTORIES.

Proper Building Construction—Materials and Manufacturing Processes Described—Fire Hazards Pointed Out.

By F. E. Roberts, Inspector, Norwich Union, Toronto, Canada.

Some kind of a transparent preservative material or varnish, applied to a painting, has apparently been known for centuries. Paintings from Herculaneum and Pompeii have been unearthed in which the colors appear perfectly bright. The varnish or preservative material was a preparation of wax. Real varnish, however, dates from the discovery of the art of lacquering, in Japan, during the eighth century A. D. Japan lacquer is essentially the juice or sap of a small tree, a natural varnish, and, as prepared and used by the Japanese, gives a lustrous and durable coating, probably not equalled by any other kind of varnish today.

Varnishes may be divided into two classes—oleo-resinous and spirit varnishes. The first consists of a drying oil, driers, resins, turpentine and usually benzine. The second consists of resins dissolved in some volatile solvent. Shellac varnish, often called simply "shellac," is the common representative of the second class. Oleo-resinous varnish is the more important class and the kind most generally meant by the term "varnish" when used without qualification.

MANUFACTURE OF OLEO-RESINOUS VARNISH.

We often see old buildings, as old dwellings which should be torn down, converted into "light manufacturing" premises, a purpose for which they are totally unsuited. Frequently there are several occupancies of this nature under one roof—a veritable hive of industry. It is not an uncommon occurrence, however, for the bees to be smoked out. "Light" manufacturing is sometimes a very apt term in more senses than one. It is a pleasing feature of varnish making that any old shack cannot be converted into a varnish factory. On the contrary, special buildings have to be erected, used for that purpose only, and wandering bees must seek hives elsewhere.

GUM MELTING AND VARNISH BOILING BUILDING.

This building should be of fire resistive construction throughout, having but one story and no basement, a cement floor, flat roof with standard skylights and no exposing windows. These buildings are frequently found with wooden roofs and non-standard skylights, and occasionally with windows.

A succession of chimney stacks, or one continuous stack, for the furnaces generally cover one entire side of the building.

Sometimes this stack is located in the centre of the building with the furnaces on opposite sides.

The furnaces are circular in form, underground, with an underground draft, the mouth being just above the floor. In operation the surface of the burning fuel (coke) is about level with the floor. In one form the stack for the furnace is built out into the room to form a hood (Fig. 1), the very wide flue being directly over the furnace. In another, the hood is thrown out from the face of the stack with a large opening into the flue. One form has a separate "vapor flue" at the back, joining the main flue (which latter is directly over the furnace), part way up. In either case the varnish pot when on the fire sets entirely within the "oven" formed by hood and dividing brick walls from other ovens (Fig. 2). Generally in addition there is a metal

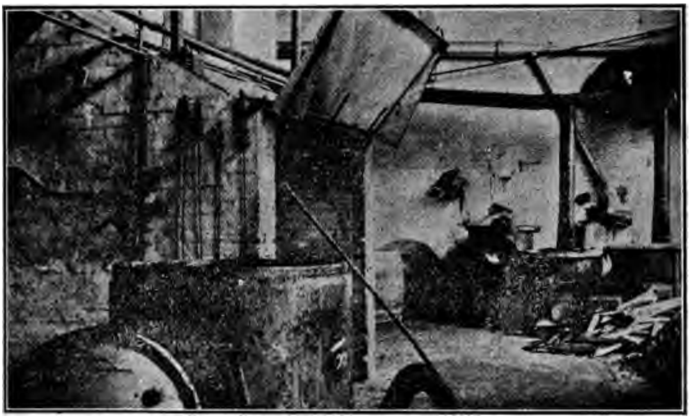


FIG. 1—VARNISH OVEN AND OIL CALDRONS.

hood attached to the oven, which can be let down when the pot is drawn off the fire.

REDUCING BUILDING.

This is usually a shed, with one side open, or with doors only on one side. The description of boiling building should apply to this, omitting the stack, ovens and furnaces, and does apply in a good factory, except that fireproof walls are still more rare. A fireproof roof is not so important, though desirable. Where the building is a brick or concrete shed with one side open (Fig. 3), giving all the light required, a light, all metal roof is sufficient.

It should be well detached from the boiling building, but sometimes adjoins one end. If any attention is paid to proper construction, there will be no communication between these buildings.

COOLING, SETTLING AND FILTERING BUILDING.

This is a small structure which may adjoin the reducing building, without communication. The same general description for the other buildings applies to this one. The roof should be of fireproof or first class construction. In some factories this building is omitted entirely.

VARNISH STORAGE BUILDING.

This should be a detached one-story building of fire resistive construction, with no basement, having a cement floor, and with blank walls against all exposures. Variations from this type will be found, but in a good establishment it is at least a first class building, having one story, with no basement, and with exposures fairly well protected.

In addition to the above there may also be buildings and sheds for storage of oils, gums, supplies and barrels, and possibly oil tanks. Benzine is generally kept in underground tanks, and in the best establishments turpentine and turpentine substitutes receive like treatment. While in some special cases it may be deemed allowable to store volatile liquids in tanks above ground, the safer way, applicable to all cases, is storage in underground tanks.

MATERIALS

[illegible] Tung or Chinese wood oil has been used to [illegible] several years. At the [illegible] prices of linseed [illegible] a good varnish oil. [illegible] from the Soya [illegible] are some of the [illegible] and the turpen- [illegible] pine needles, [illegible]

[illegible] is purposely [illegible] as mentioned un- [illegible] sometimes con- [illegible] is generally our [illegible] is liable to [illegible] a fire as the [illegible]

[illegible] trade, though [illegible] water, while [illegible] principal resins [illegible] zanzibar,

elemi and rosin. With the exception of rosin all are products of Africa, South America, New Zealand, East Indies, Philippine Islands and other islands of a tropical or semi-tropical climate. Rosin comes principally from the southern United States. Amber, which may be used in some expensive varnishes, is found on the shores of the Baltic in Germany.

These resins occur as "fossil resins" buried under more or less earth, as exudations from living trees, and some varieties in both forms, the fossil resins being of higher quality. Copal and kauri form the principal ingredients of any resin mixture for good varnishes, while rosin is the chief resin for cheap varnishes.

PROCESSES.

There is little machinery required, being confined entirely to pumps and filter presses or separators, with possibly a washing drum for cleaning filter cloths with benzine. The utensils are of a very simple nature.

The process of making varnish may be divided into four parts: melting or "running" the resins; addition of oil and driers and boiling the mixture; reducing or thinning with turpentine and benzine; cooling, filtering and "ageing" in closed tanks.

The pots (Fig. 4) in which the resins are melted and varnish boiled are of copper, cylindrical in shape, about 40 inches in diameter and 36 inches high, having a capacity of about 150 imperial gallons. The pot rests on iron carriages on wheels, so they can be drawn on and off the fire and transferred to the reducing shed for thinning. Each pot is fitted with a thermometer, an exceedingly necessary feature. There is also a cover with an opening in the top to which can be attached a pipe leading to the "vapor flue" if one is provided; otherwise it is left open. The covers are used only during the "running" of the resin.

The resins have to be heated beyond their melting point, in fact to the point of partial decomposition, in order to be soluble in the oil. This of course produces a vapor which is inflammable. The oil is also heated before being added to the melted resins, sometimes in a fixed iron cauldron, fire heated, similar to those in common use for "trying out" fats. The oil reaches a temperature of perhaps 250 degrees. Driers are added during the process of boiling the varnish or they may be contained in the oil previously treated. The mixture of resins and oil forms only half or even less of the capacity of the pot.

THE TEMPERATURE EMPLOYED IN MAKING VARNISH depends on the resins used and also on what each varnish maker may deem the proper temperature for the varnish he is making. Probably 650 degrees is about the high mark. When the varnish maker considers the mixture is sufficiently cooked, the pot is allowed to cool down preparatory to thinning. The whole proc-

ess of making varnish, including the thinning, can be readily completed within working hours.

Although the mixture is cooled down before thinning it is not exactly cold when ready, for the thinning may be done while the mixture has a temperature of 300 degrees. It is easy to understand, therefore, that copious fumes are given off when the turpentine and benzine are added, even when this is done slowly, with vigorous stirring, and the reducing shed should be so located or arranged that the fumes cannot travel to the furnace fires. In one method of thinning, the turpentine and benzine are pumped from underground tanks to graduated cylinders on the wall only as required for use. From these cylinders the liquid flows slowly by piping, sometimes ending with a rose, to the varnish pots.

In one variation a supply of about two barrels is pumped to elevated tanks outside the building from which it flows to gradu-

FIG. 2—VARNISH OVENS.

ated cylinders. The stock tanks containing turpentine may be located at some distance and elevated, from which the flow is directly by gravity to the building or just outside of it, measuring cylinders being dispensed with. Turpentine and benzine may be brought in from an outside supply in containers as required—or a barrel or more of turpentine and benzine brought into the building and contents removed by a hand pump to containers for thinning. The first method is certainly the best from a fire point of view.

THE AMOUNT OF THINNING MATERIAL USED,
or its composition, depends on the kind of varnish being made

and above all on the price. For an average varnish probably the proportions of resin and oil mixture and thinners will be about 60 per cent. and 40 per cent., and the thinner perhaps two-thirds turpentine or turpentine substitute and one-third benzine. For a cheap furniture varnish the thinner may consist in part of something resembling turpentine, but it is tolerably certain the varnish will contain as much benzine as it can stand up under and still be a varnish.

After the thinning the varnish is handled entirely by pumps. Sometimes when it is thought to be cold the varnish is pumped from pots in reducing building, directly to storage building. Generally, however, the varnish is pumped into cooling and settling tanks in an adjoining building, afterwards pumped through a filter press to the storage tanks in a building preferably detached. The filter press is the same type used in color manufacture, only in this case the liquid is the product and the sediment the waste. A separator may be used, this being a centrifugal machine similar to a cream separator.

An objectionable variation is to have the settling tanks, filtering press, pumps and storage tanks all in one building. Varnish is very likely to be hot, with accompanying fumes when pumped into settling tank, and there should be no mechanical process carried on in storage building, nor anything but cooled varnish pumped into it. The tanks in storage building are closed and good varnish receives a period of "ageing," which may be a year or even more. Cheap varnish requires no extended period of "ageing." It is probably incapable of much improvement by that method.

JAPANS.

The process of making the ordinary black "dipping" japan is essentially the same as making varnish. Asphaltum, or asphaltum and coal tar pitch, are the gums, and the thinner is turpentine or benzine, depending directly on the price of the japan. Ordinary open iron cauldrons are used on wheeled carriages as in making varnish. No filtering or "ageing" is required. Stored in tanks similar to varnish. The process is not so exacting as varnish making, and requires less heat.

HAZARDS.

The principal hazards of resin melting and varnish boiling consist of the ignition of vapors, boiling over and overheating. The first danger is more apparent in the resin melting, for the vapors are abundant and very inflammable. If they come in contact with furnace fire, through a "back draught" or any other cause, a fire is the result. With the wide flue and good draught usual in varnish factories, fires are not numerous.

Both the resins and mixture of resins and oil are liable to foam

excessively and "boil over." Presence of water increases this danger. It is said after the resins are thoroughly incorporated with the oil the danger is much less during subsequent heating. The pots are carefully watched and any tendency to excessive foaming allayed by drawing off the fire and "beating down" the foam.

Possibly there is not a very wide margin between the heat liable to be used and the temperature of ignition of varnish or vapor arising from the same. Whatever the reason may be, the state of the thermometer is an object of the utmost solicitude on the part of the varnish maker, and the danger would appear to be an overheating of a portion of the mixture, with a consequent "caking on" at the bottom of vessel rather than the overheating of the entire mass. As the contents of the pot are stirred frequently this is not liable to occur. In fact the whole process is one of care. Varnish pots on the fire are not left to run themselves.

VARNISH MAKING IS A TRADE

and one that requires skill and experience, especially up to the thinning stage. Skilled workmen are therefore employed and under their care the danger of heating a highly inflammable mixture is reduced to a minimum. Varnish fires in the gum melting and varnish boiling building are not so numerous as may be thought, and it is not impossible to extinguish all such fires at their inception. Where not extinguished in a properly constructed and located building, the loss should be no greater than the contents of one varnish pot, possibly including the vessel itself.

Water is of no use in extinguishing a fire in a varnish pot. Exclusion of the air is the only remedy. This is best accomplished by the cover, aided by wet blankets. Sand is useful for preventing spread of burning oil and smothering the furnace fire. The liability of a larger loss than one pot of varnish is due to the fact that the pot may be withdrawn from under the hood in an unsuccessful attempt to extinguish a fire. If there is a wooden roof, it may be ignited, and other pots of varnish may also be ignited. It is, therefore, apparent why there should be a fireproof roof, and also why there should be no storage whatever in the building. One or more oil tanks are sometimes found. This is certainly a defect.

With a fireproof building, well detached and without storage, the chance of a large loss in the building itself, or loss by exposure to other buildings is small.

THE HAZARD IN VARNISH THINNING

is simply that of the fumes igniting at some fire or spark. While the heat of varnish mixture is sufficient to produce copious fumes, it is not sufficient to ignite the fumes. In most instances ignition is caused by unsafe location of the reducing building in

reference to the furnace fires of the boiling building. There have been rare cases where there was no fire which could have caused ignition. Probably there was a spark on bottom of kettle. The fumes in a still air would simply overflow from the pot like water, fall down, meet the spark and ignite. With copper pots and coke fires this danger is not imminent. However, one varnish maker claims he looks after this hazard before thinning.

Benzine vapor will travel a considerable distance, ignite from open flames or fire, and flash back to the main supply. This is said to have occurred over distances of from 33 to 40 feet, depending upon the state of the atmosphere and the direction of the air currents. While turpentine vapor is not so insidious, it would probably not be a very safe operation to thin with turpentine within twenty feet of a fire.

If the reducing shed faces the doors of the boiling building, or any opening, it should be 45 to 50 feet from any fire, unless some effective method of ventilation is adopted to carry off the fumes. In one case the reducing shed faces the end of the boiling build-

FIG. 3.—REDUCING BUILDING WITH VENTILATING SYSTEM.

ing, which has a door that may be open. There is a distance of 20 feet between the buildings. Over each pot where thinning is done there is a hood connected with a vapor duct extending along the back of the building, with a suction fan on the outside. There is also a pit, covered by a grating at the front, to which the duct is brought down at one end.

that any of the heavy fumes which may escape from being drawn up the hood, will collect in the pit and find their way out by way of the extension of the vapor duct. In practice it seems to work perfectly and very little odor is perceptible outside of the shed. In another factory the front of boiling building faces the solid back of reducing building with a space of from 15 to 20 feet between them, which is satisfactory.

Where the reducing shed adjoins the boiling building at one end, even with no communication between them and the doors of both facing the same way, the arrangement can not be considered as satisfactory. While any fumes would have to "turn the corner," so to speak, to get at the furnace fires, yet there is

FIG. 4.—VARNISH POT.

a possibility of their doing so. It may be remarked that no dependence can be placed on doors of boiling building being closed, or fires being out, when thinning is going on, however the buildings are located. If pumps are in the building they may be of the rotary type requiring power. If electric power is used no motor nor connecting wires should be installed here.

They should be placed in a small addition with a solid brick wall separating, and with no opening except shaft hole.

AN APPROVED SYSTEM OF ELECTRIC LIGHTING

is not objectionable in gum melting and varnish boiling building, but if light is required in the reducing shed it should be only the best system possible of electric lighting for places subject to combustible vapors. This would mean conduit wiring, and fixed vaporproof bulbs, near the ceiling, light turned on from outside. Heat is not required in boiling building and generally reducing shed is too open to allow of it. If heating is desired, only well installed steam or hot water from an outside source should be allowed

The operations of cooling, pumping and filtering present no especial danger with an approved system of electric lighting, steam or hot water heating. The building or section should be separated from reducing shed by solid fire wall. While a motor may sometimes be found here, it would be better outside located the same manner as recommended for reducing building. A separator for filtering varnish is a very rapid running piece of machinery. It will have at least the frictional dangers always present in such machines, and the filter press is preferable from a fire hazard point of view.

THERE IS AN OILY RAG HAZARD

in discarded filter cloths, and in addition, where apparently expensive filter cloths are used, there is the hazard of washing in an oscillating drum of benzine. Filter cloths that are not too expensive to be burned up every night are much to be preferred.

The reason why the varnish storage building should be of fireproof construction, detached and free as possible from exposure, is mainly because it is here that very large values in proportion to other buildings of plant are assembled. It is necessarily heated either by steam or hot water, preferably from an outside boiler house. If boiler house adjoins, it should be cut off by a solid wall, with no opening by fire door or otherwise. The varnish storage should be protected not only from fire dangers originating in boiler room, but also from any fumes finding their way to furnace fires. The advisability of a one story building with cement floor, no basement, and cement platforms for varnish tanks, is apparent. It can also be seen that the presence of settling and cooling tanks of hot varnish, and the process of filtering or bringing the pots of varnish, possibly hot, inside of the building for transference to tanks, are objectionable. If a power pump is required it should be steam.

While there is probably no exact chemical union between the thinning material for varnish and the resin oil combination, yet

at ordinary temperatures, even with a cheap varnish, there is probably not so much vapor given off as would be evolved from the thinners alone, and in a good varnish fumes are not very extensive. When a varnish is hot, however, the combination, if any, is broken up and fumes more or less extensive are given off, depending directly on the kind and amount of thinners used.

FIRE PROTECTION.

The gum melting and varnish boiling building should contain six buckets of sand with auxiliary supply of sand in a bin or barrel. There should also be a barrel of water containing woolen blankets or bagging. The reducing building should be provided with similar protection, and the cooling and filtering sections should be provided with pails of sand.

The varnish storage building should contain approved chemical extinguishers and pails of sand.

AUTOMATIC SPRINKLER AND STEAM JET PROTECTION.

A sprinkler system is not recommended for melting and boiling, or reducing buildings, and is of doubtful value in cooling and filtering, or varnish storage building. If fire does not originate in a tank or in close proximity thereto, sprinklers will probably be effective, but with a tank of varnish on fire, water might do more harm than good. Steam jet protection is not available for the first named structure, owing to wide open chimney flues. It is advisable for the second, if it can be fairly well closed up, and decidedly of value for the third, which is generally of small area and closed. As to varnish storage it will be effectual if area is not too large. The actual evidence on the subject is contained in a valuable report by H. A. Fiske of tests made at the Standard Oil Cloth Company's works at Athenia, N. J., published in the January, 1910, issue of the *Quarterly*. It was conclusively shown that steam at 90 to 100 pounds pressure, 2 inch supply pipe, with one 1½ inch outlet, extinguished the flames from about twenty gallons of a very inflammable varnish on fire, in less than a minute. Building 15 feet by 22 feet, 16 feet high, containing about 5,000 cubic feet. Door openings closed in usual manner by fire doors. It really seems to be a question of boiler capacity and number of jets (with an adequate supply pipe), as to how large an area can be effectively protected. It is only steam under considerable pressure that can be relied on as a fire extinguisher, probably not less than 60 pounds--better, 100 pounds or more. Steam under pressure will not mix with air, but drives it away from contact with a burning substance, substituting its own vapor, which will not support combustion.

EMBROIDERY WORKS AND ALLIED TRADES.

Manufacturing Processes Described—Fire Hazards Pointed Out—Susceptibility of Stock.

By Walter O. Lincoln, Inspector, New York City.

"Fashion" decrees that milady of today bedeck herself with various sorts of dress braids and trimmings. It is for this reason that there are so many styles for each season of the year.

The manufacturing of embroideries comprises several branches involving the use of different, specially designed and intricate machines. Braid manufacturers seldom engage in other branches. The making of cords, tassels and chenille is always separate. Passementeries, hand, bonnaz and imitation hand embroideries, with a side line of scalloping and hemstitching, is a class by itself. Swiss embroiderers may include some of the latter work. All except the Swiss embroiderers do plaiting, crimping, steaming, pattern making and stamping.

BONNAZ EMBROIDERY

consists of sewing braids, cords, spangles or beaded cord by machinery onto a piece of dress goods, lace, netting or temporary buckram backing.

The best machines are of German or French make. They are designed to sew one to four strands to the goods at one time, an operator guiding the material by the handle under the base of the machine. The strands may be of different material. The machine very much resembles the ordinary sewing machine in construction, operation, weight and outline although the parts are more intricate. Hemstitching, scalloping and imitation hand embroidery machines are similar to the bonnaz. No heat is required and motor power is in general use, a row of machines being set up as in clothing factories. The consequent hazards are oily floors, linty bearings or perhaps scraps on floor becoming ignited by a cigarette.

BRAIDS.

Fig. 2 shows the type of machine for making cords, flat, round, elastic or soutache braids. They are of special design, the mechanism differing somewhat for each kind of work, but the operation and appearance are similar.

In this class of work, whole floor areas will be found crowded with braiding machines of heavy iron frames, necessitating substantial floor construction. The floors are always very oily.

The threads are received from the mills in skeins, hanks or large spools. A braid spooler measures and transfers the thread to the smaller machine spools. If desired, a machine covers the cotton thread with silk. The spools of silk are set over the braiding machine, which consists of numerous small spools, set in a groove in base of machine, rotating and crossing each other

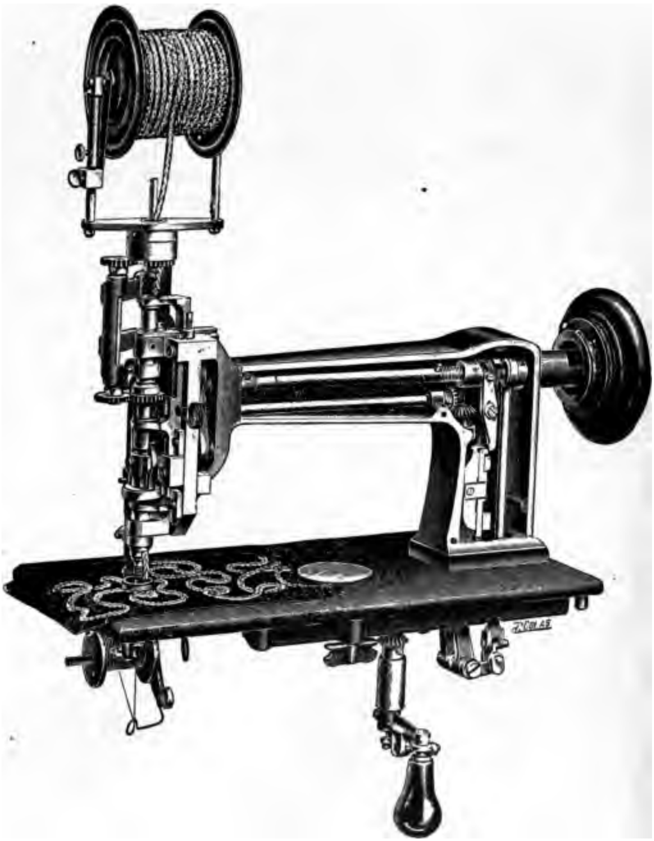


FIG. I.—BONNAZ EMBROIDERER,

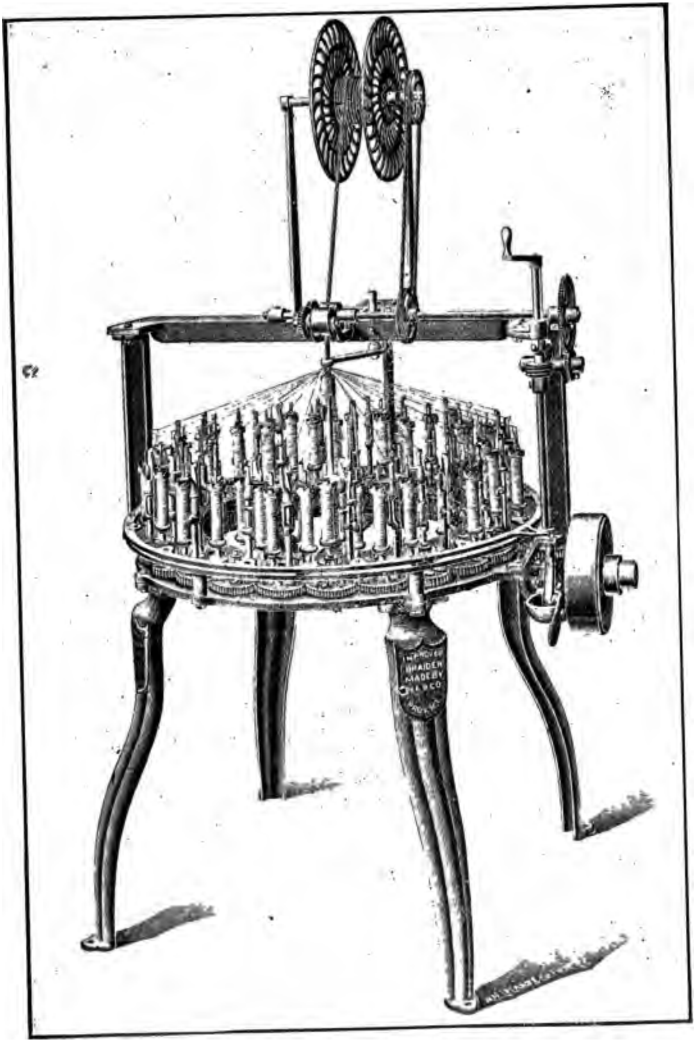


FIG. 2.—BRAIDING MACHINE.

to make the necessary twists. As many as ninety-six strands are braided at one time. To soften the braid and make it more pliable, it is passed over the spout of a gas or steam heated steamer. Braids coming from the machines with rough or frayed edges are singed with a gas flame singer which burns off the roughness. This singer is far superior and safer than the now extinct method of singing with alcohol, gasoline or kerosene burners. The goods are passed over a small gas flame, the distance being regulated according to the texture of the nap, whether hard or soft, the latter being more readily ignited.

CORDS

are made on machines similar to the bonnaz and the chenille machines. When made on the chenille machine, a "carrier" is attached to the ends of the threads, which being moved along, twists the strands. As the "carrier" reaches the hanging frame, the ends are cut and fastened and the operation repeated, the cord machine being moved along as the threads tighten, an operator repairing broken threads along the line. Tassels are made of chenille or cord, the head being drawn and bound either by hand or power winders.

CHENILLE

is the heavy, soft finished corded goods used for portieres and draperies, and the silk or cotton covered wire used by milliners for flower stems, small buds, and fastening flowers on hats, and by dressmakers for fastening trimming on gowns. The yarn is spun on a loom, placed on spools, drawn through the chenille machine (Fig. 3), to a wooden frame on opposite side of the room where they are fastened to spools on a semi-circular frame over a large wheel, and attached to same by a rubber belt. The reverse action of this wheel and the chenille machine twists the strands. If fringed chenille is desired, such as used for fancy flower stems or millinery ornaments or buds, the edges of the chenille are cut at regular intervals by a small knife as the strands pass through the machine. Numerous fringed designs can be made by the use of cams or chucks. This process is as "old as the hills." Wooden machines are generally used and it is claimed they are superior to the iron ones. A newly patented, compact and motor driven machine, requiring small space and doing the work of several men, is in use in a few shops. On this, the threads are wound at the bottom on spools, pass around numerous small wheels, are twisted and the finished chenille spooled at the top. By the older method, considerable space is required, from five to fifteen yards in length and about six feet in width for each machine.

is used extensively for summer waists of the "see more" variety, whole dresses, trimmings and flounces. It is a business by

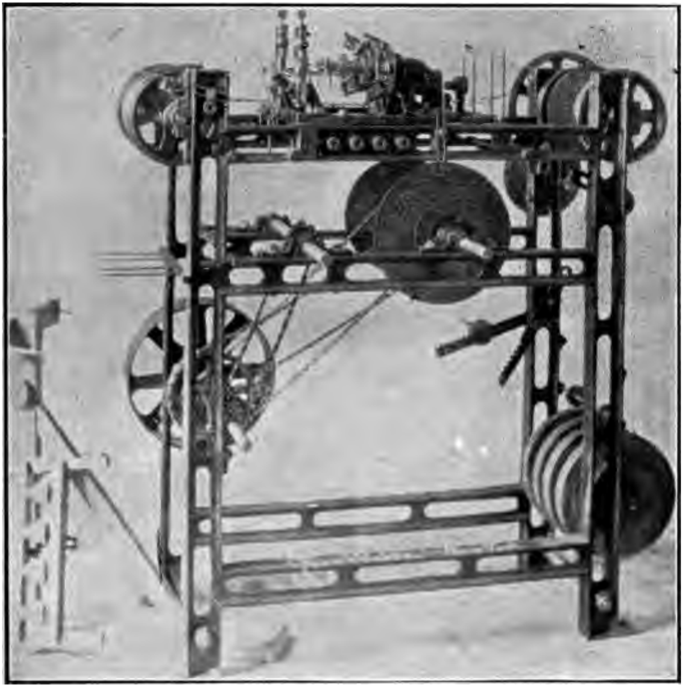


FIG. 3.—CHENILLE MACHINE.

itself, being made by firms having two to ten machines usually purchased on instalments.

Swiss embroidery is made on a long cumbersome machine (Fig. 4), of iron frame, five to fifteen yards in length, and weighing two to eighteen tons. The pattern is placed on the board at the end of the machine, an operator tracing it with the pantograph or arm, which also controls the operation of the machine. There are two rows of needles from one hundred to two hundred in a line with a punching and festooning apparatus.

Owing to the great weight, the machines are best located in basements or on first floors. They should be on concrete bases to minimize vibration; and if above basement, concrete pillars should extend from ground to base of machines to prevent collapse of floors in case of fire. Motors are universally used. Floors are oily and metal pans with flanged sides should set under the motors to catch the drippings. A row of electric lights or gas lights along the frame assists the operator to inspect its workings. Gas jets on swinging arms are very dangerous. They and electric lights should be enclosed in heavy wire guards to prevent them from coming into contact with the embroidery. Aside from the fire hazard, it is a loss to the manufacturer or contractor to have the goods scorched.

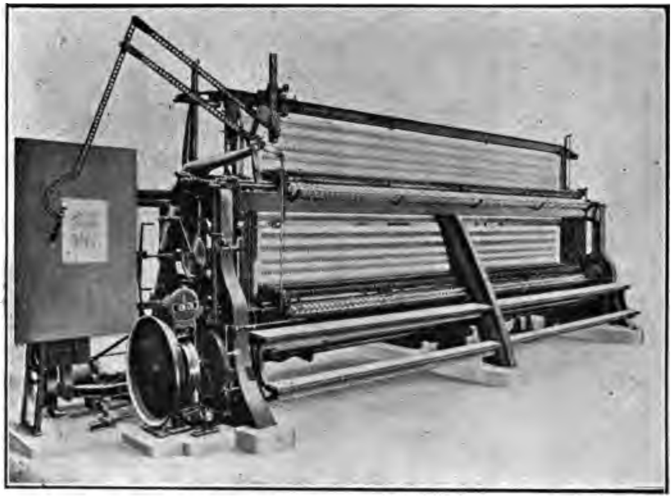


FIG. 4.—SWISS EMBROIDERY MACHINE.

THE AUTOMAT.

It is to the Swiss machine that the automat (Fig. 5) is attached. The illustration will give an adequate idea of the Zahn apparatus, which practically eliminates the human factor in manufacturing Swiss embroidery. According to the trade, there are less than two hundred automats in use in America as against over two thousand in Europe, due to the monopoly of the Groebli by virtue of patent rights in America, it being

claimed the Sauer, Zahn and Kappel were infringements. In New York City there are less than one-half dozen in use. The general impression in the trade is that the infringements have been overcome, as the Zahn has been advertised for general use. The automat bears the same relation to the embroidery machine as the auto piano player to the piano; the pattern or design being punched into the paper which passes through the automat in same manner as does the paper roll in the auto piano player. The automat can be attached to any Swiss machine with little expense. The Zahn automat is said to increase production 30 to 50 per cent. A capacity of 125 to 135 stitches per minute is claimed for it against the average capacity of 85 to 105 on the pantograph machine. Ten automats are all that can be operated economically, an expert machinist being necessary to maintain the efficiency of the automats whether one or ten, and one machine for making patterns can amply supply ten automats. At hand work an operator is required at each machine receiving forty cents for each 1,000 stitches credited by measurement of the design. The greatly improved quality of the goods turned out by the automat will probably result in the repudiation of the allegation that American made embroidery, as a whole, is inferior to the foreign. The general use of the automat will no doubt revolutionize and enlarge the trade unless the price ($2,500, including pattern machine) is prohibitive.

PASSEMENTERIE

is the edgings, bead, gimp or lace work trimmings for garments. This is the least hazardous process where stamping and pattern making is absent. Most firms specialize in this line, employing girls. A piece of netting is placed on four sticks similar to a curtain stretcher, on each side of which sits a girl sewing the braid, cord, spangles or bead work to the goods.

PATTERN MAKING.

Before any embroidery can be made a design must first be drawn on a sheet of paper and cut out with a foot power perforator. A heavy sheet of felt under the pattern protects the needle of the perforator.

The perforated pattern is placed on the goods to be stamped and embroidered. The pattern is transferred (called stamping) to the material either by rubbing over the perforations a piece of colored wax, lampblack thinned with benzine, turpentine or kerosene, charcoal, a dry rosin powder or a specially prepared powder. In the cheap grade shops newspapers are used for patterns and burnt paper from the carbonizing oven for stamping.

"All-over" braid designs are usually sewn on a temporary buckram backing previously sized with dilute sulphuric acid, which makes it rather brittle and easily burned. After the braid

is sewn on the piece is placed in the carbonizing oven on wire racks. This oven is a metal box with gas flame at bottom and vented either to the room or a brick flue. The embroidery is placed directly over the gas flame. At a certain temperature the buckram disintegrates and can be easily brushed off, leaving the

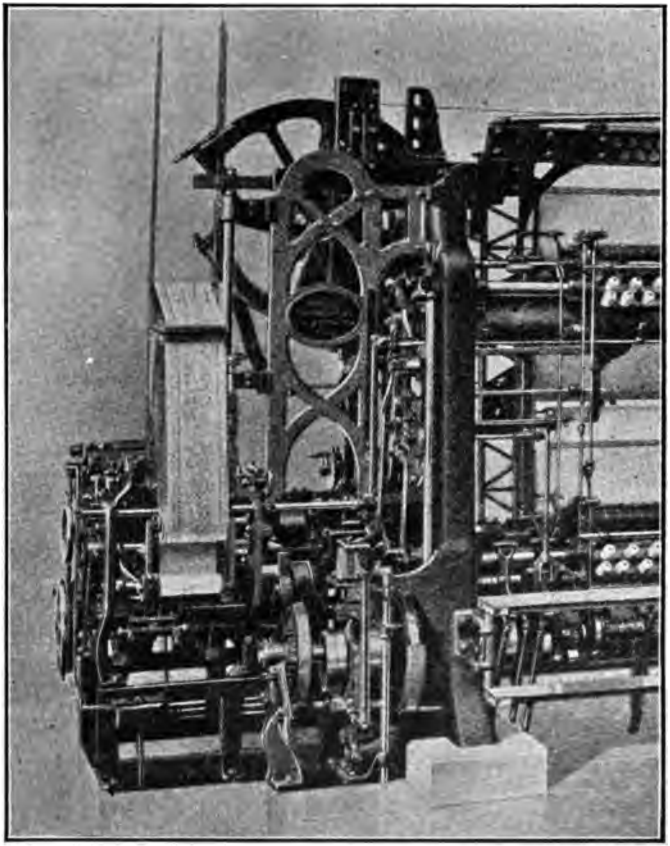


FIG. 5.—ZAHN AUTOMAT.

embroidery unharmed. The sizing of buckram is a separate trade and not done in the shops.

Machines for plaiting, ruching, fluting and crimping are necessary adjuncts to the embroiderer. These are invariably gas heated. If the rollers are overheated the goods are scorched and stick. The hazard is not severe especially when operators are confronted with signs reading, "Operators will be fined for damaging goods." Fluters, crimpers and ruchers are on the same general style.

RAMIE

is a shrubby Chinese or East Indian perennial of the nettle family with numerous rod like stems four to six feet high and large heart shaped leaves silvery white beneath; cultivated in the West Indies and United States. The fine fibre yielded by the stem of this plant is now coming into use for almost every purpose heretofore served by cotton. It is very strong and durable. Braids, trimmings and even napery and imitation willow plumes are now being made of ramie. In appearance it is similar to thrown silk and woven similar to straw braid in straw hat factories. •

The "sliver" or loose ramie is fed to the machine, passing through a glue or starch sizing pan; between gas heated calender rolls and automatically wound on the drying apparatus over steam coils. If an additional gloss is needed it goes to the second gluing machine. A gas heated smoothing machine about the size of a large plaiter removes all roughness, after which the ramie is cut into strips and braided.

Bleaching of embroideries is done with extract of benzoin or hydrogen peroxide.

Cleaning is done with alcohol, turpentine, benzine, chloroform or similar substances.

Dyeing is done with aniline dyes soluble in sulphuric acid, benzine or water. Few firms do their own dyeing.

"AGING" OR REFINISHING OF WHITE EMBROIDERIES AND TRIMMINGS.

As the goods in hands of wholesalers, retailers or jobbers become shopworn or discolored they are "aged" or refinished. Most firms use aniline color soluble in benzine. The color and benzine are bought in small quantities and used from an open dish. Another method is placing the goods in a wooden, hand-turned tumbler in which is first placed a non-hazardous dry powder called "Dutch white." As the tumbler revolves the powder turns the material to a light creamy yellow, a much desired shade.

HAZARDS.

The majority of embroidery machinery is of French or German make, although there are a few domestic braid and Swiss machines. Orders for many of the foreign machines must be

placed a year in advance of delivery. Broken parts are hard to replace without sending abroad, at times requiring the shutting down of the plant for long periods (care should be exercised in writing use and occupancy insurance) or the purchase of new machines in hands of local agents. All the machines, especially the bonnaz and imitation hand embroidery, festooning, scalloping and hemstitching, are intricate in design, subject to *severe water damage,* and should have rubber hood coverings at night, not only to prevent water damage in case of fire, but to prevent the collection of dust in the small parts which soon wears out the machinery. It seems feasible to suppose that a hood can be made for them to remain on the machines during operation. An open slit or mica front is all the operator requires and its use would prolong the life of the machines. It would be a saving both to the manufacturer and insurer. Being of iron frame, considerable salvage can be expected if they are oiled immediately after a fire to prevent rust.

When fringed chenille is made the clipping of the fringe literally cover the machine, which, being mostly of wood and very oily, creates a hazardous condition. The operators are piece-workers receiving twelve to fifteen cents for each 140 yards of chenille of the cheap grade and up to forty cents for the best grade. At this small wage they cannot be expected to take the time to remove the lint. The cost of the machines of the bonnaz type varies between $90 and $175. The Swiss machines are the most expensive. Excluding the automat the cost is between $3,200 and $4,500. Complete machines of certain foreign makes cannot be delivered for nearly two years after order is given. The majority used in this territory are purchased on instalments, $100 monthly payments being the rule. The setting of Swiss machines is of paramount importance, as previously stated.

MORAL HAZARD.

The moral hazard is always present and firms operating on small capital should be watched carefully. A great number of new firms have sprung up in recent years, doing business on a small scale, employing but few operators, and mainly located in cheap loft buildings. These "small fry" receive only the left over orders of manufacturers or work under contract. They "specialize" in one line until they receive a few orders for other classes of work. The class of help and condition of shops is the same as found in the majority of garment factories. In the old reliable plants, good care is exercised.

GOOD HOUSEKEEPING

is an essential feature. Oily floors conduce to the rapid spread of fire, and should be swept daily. An occasional scrubbing with lye soap is recommended. In braid factories it is not prac-

tical to place metal under each separate machine, owing to crowded condition. To prevent floors from becoming oil soaked, a cement covering is excellent. Motors should set in metal pans with flanged sides to retain oily drippings. Linty bearings should be cleaned regularly and often. Gas singers of the up to date patterns are reasonably safe in hands of careful people. In former years, the use of benzine, alcohol and kerosene burners was responsible for many fires. All gas connections whether to steamers, plaiters, crimpers, fluters, ruchers or sizing kettles should be of iron piping and not rubber tubing; but steam heat is always preferable. At the ramie machine, the gas flame under the sizing pan is usually about one foot above the floor. A metal pan under the burner will prevent hot carbon from falling to the floor. A wire guard around the burner prevents papers or scraps from being blown against the flame. If live steam is used at the drying frame, a metal screen should be placed over the coils to protect fallen goods. Coils should be two inches from woodwork, and at least ten inches above the floor to allow frequent sweeping. Gas or electric lights at Swiss machines should have wire guards. Although fire may not ensue from lights coming too near the goods, scorching may ruin an entire length of embroidery, and be a loss to the manufacturer or contractor.

Pattern making, stamping and cleaning should be rigidly investigated. The use of volatile liquids in open vessels in rooms with open lights is dangerous. As this is done on a small scale, there is no occasion for storage of large quantities. Ordinarily, benzine or similar liquids are stored in safety cans, but invariably used from open vessels.

The carbonizing oven is necessarily heated by gas to produce the direct heat for burning off the buckram backings from the embroidery. The frame should be of angle iron; sides, top and bottom of double thickness of sheet iron with the intervening space filled with at least one inch of asbestos; doors of similar construction with wrought iron hinges and latches; the vent pipe connecting with an outside brick flue or chimney. The trays or racks should be of heavy wire netting and a finer screen three inches over the burners will prevent the accidental burning of embroidery while being placed in or taken out of the oven. The entire oven should either set on a brick base or on six inch iron legs riveted to the frame work with sheet metal under.

The machine repair shop feature is always present in large factories with the attending hazards of oily waste, oily floors, gasoline torches, gas soldering mufflers, gas glow pipes and annealing furnaces for tool hardening.

Packing material consists of tissue paper and card board. Patterns are made on expensive paper (except cheap grade

shops where newspapers are used), and constitute considerable value, are susceptible to water, smoke and fire damage, and should be stored in a fire-proof vault or safe. It is common, however, to find them hung on hooks or nails in the work rooms. As seasons change, patterns, except standards, become obsolete and are valueless to the manufacturer until after a fire when the value most wonderfully increases.

Stock is very susceptible. Water tends to streak, mildew and make the colors run. Except display stocks in hands of jobbers or wholesalers, stock is usually kept in card board boxes on shelves and protected from smoke and water.

Hazards of Silk Manufacture.

True silk by itself is, from a fire risk point of view, the least dangerous of all fibres; it will, in fact, stand heating up to over 300° Fahr. without change. Since the heat in silk drying compartments is very great, being from 240° to 260° Fahr., the highest for any fibrous material, the possibilities from the presence of any quantity of foreign fibre or other matter are obvious.

As silk fibre is solid and not hollow (like cotton, for instance) it is difficult to burn; but, on the other hand, when once it has absorbed heat it is most obstinate in parting with it, and retains it more than any other fibre. The manipulation of pure net silk is fraught with but little fire risk, but the extraordinary powers of absorption (of both liquids and solids) are possessed by the fibre, and are one possible explanation of the seemingly inexplicable outbreaks of fire which occur from time to time.

Silk can be loaded up to 300 per cent. of its original weight, and most of the principal loading agents comprise materials containing tannin. But lead picrates, antimony compounds, fats, ferrous salts, etc., are sometimes employed, some of which render a mass of material so loaded liable to spontaneous heating, i. e., spontaneous heating of the loading matter—and the property of silk for retaining the heat aids its combustion. Tannin, of course, is innocuous, and it is desirable to ascertain, where possible, what loading materials, if any, have been used, and to what extent.

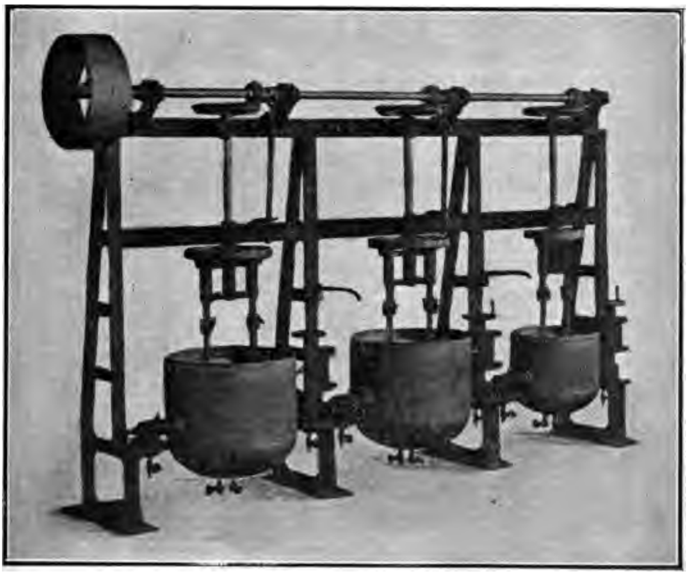
Owing to the very light and fluffy nature of all silk waste there is considerable fly in rooms where preparatory processes are carried on, and a tendency towards accumulation of fluff and dust on shafting and bearings.

ARTIFICIAL LEATHER MANUFACTURE.

Description of the Processes Used and Hazards Attending This Industry—Suggestions for Improving Conditions.

By C. B. Mackinney, Secretary Inspection Department, Starkweather & Shepley, Providence, R. I.

In the old "Seven Dials" district of London there appeared over the door of a little harness shop the legend, "There is nothing in the world like leather." This may have been a true statement at the time, but it does not apply now. Man has devised a method of making substitutes for the natural product which are like leather in appearance, "feel," strength and various other qualities; wear and keep their appearance better than the



MACHINE FOR MIXING COATING MATERIAL. THE KETTLES ARE STEAM JACKETED, AND WHEN IN USE ARE COVERED.

real article, and do not deteriorate with age.

The writer has seen almost every conceivable article usually made of leather, fashioned from one of the various substitutes with very satisfactory results. These not only include upholstery materials, traveling bags, pocketbooks and purses, but harnesses and even very passable shoes. The demand for imitation leather for upholstery in automobiles has grown to large proportions within the last few years. As it will clean easily and wear well, and is not damaged by being alternately wet and dry or hot and cold, it is particularly adapted to the purpose.

As the artificial leather industry is increasing in importance, and as some of the processes are peculiar and the fire hazards are severe without proper treatment, a brief article on the subject may be of interest to fire insurance men.

IMITATION LEATHER

is made of paper, wood pulp, celluloid, and probably other materials, but by far the most important product is made by spreading various substances on cloth, and we will therefore confine ourselves to the discussion of its manufacture.

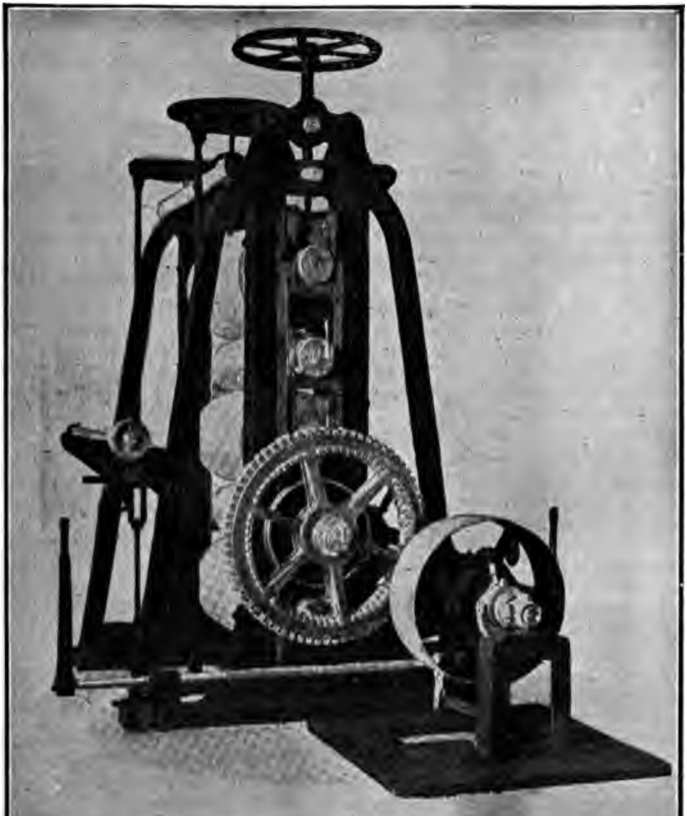
The basis is generally good, strong, unbleached cotton cloth, known to the trade as sheeting. This is received in bales. It is first run through a napping machine, then shrunk, sometimes dyed, sized and dried on can or tenter dryers. These processes are all familiar, and are not particularly hazardous.

The cloth is then ready for coating. The principal ingredient of the coating is cotton, which is brought to the plant in the original bales, opened and run through an ordinary cotton picker. It is then washed in hot water, dried in a steam heated dryroom, and then nitrated by being treated with acids, and again washed and the water dried off in a centrifugal extractor. The nitrated cotton is then dissolved in a mixture of alcohol and other solvents, and forms a paste or "jelly." In some cases scrap celluloid is dissolved with the nitrated cotton, but this is not usual and does not produce the best results. This "jelly" is then mixed with other ingredients, and is then ready to be spread on the cloth.

The cloth is coated by passing it through a hopper filled with the coating material, and then through a set of rolls. The cloth then passes back and forth through a steam heated compartment, and the alcohol and other volatile constituents of the coating material are driven off.

The coated cloth is then finished in a variety of ways. Some is varnished, some is enameled in black and various colors, but most of it is embossed to give it a leather-like surface. This is done by running it between steel rolls which have the necessary design cut on them. The finer grades are pressed between steam heated plates, which have the lines which show on real leather

exactly reproduced on their surface. There is some further coloring and finishing by hand, and after varnishing the product is finished. There is little, if any, hazard attaching to the finished product, and it is not very susceptible to smoke or water damage.



Calendering Machine. The Rolls Shown Give the Surface of the Product Its Leather-like Appearance.

The above briefly described processes are for the most part simple, but the hazards involved, particularly in the manufacture of the coating material and the coating of the cloth, are severe.

DESCRIPTION OF A WELL ARRANGED PLANT.

Proper storage sections should be provided for cotton, cotton cloth and finished goods. Detached one story brick storehouses divided into moderate sized sections of the type familiar in cotton mills will be found most satisfactory. If the storage is not extensive it can be in a section adjoining other buildings of the plant, and if a communication is necessary it should be protected by fire doors.

The napping process takes up little room, one machine being able to turn out enough cloth for a large plant. It should be in some non-hazardous section, and in a room of non-combustible material, or at least lined on sides, ceiling and floor with metal.

The further preparing of the cloth has no particular hazards connected with it, and these processes can be arranged to fit circumstances.

THE MANUFACTURE OF THE COATING MATERIAL is very hazardous and should be subdivided as much as possible. In the modern plant the first building would contain the cotton washing, picking and drying. The batches of cotton are usually so small that the picker is arranged to deliver onto the floor or into boxes on wheels or trucks. The cotton is then washed and blown into steam heated dry rooms. These rooms should be made as small as is practical. They should be built of brick or other non-combustible materials, or lined with metal. They should be so arranged that the space around the steam pipes or other heating element can be easily inspected and readily cleaned out. These rooms should also be protected with steam jets either automatic or hand operated, and some quick method should be provided for shutting off the blower in case of fire. This is also sometimes done automatically.

The dry cotton is then taken, usually in boxes holding about 50 pounds each, into the acid house. Here it is put into vats containing nitric acid. These vats are covered and the fumes drawn off by a blower. On account of the acid fumes all the metal and woodwork must be painted with an asphaltum or similar paint to prevent corrosion and decay.

When the action of the acid on the cotton has progressed far enough the cotton is removed from the acid and washed in water, and placed in centrifugal dryers. At this stage the cotton will burn, and as it becomes dryer it burns more fiercely, and when thoroughly dry will explode. It is not intended to allow the cotton to dry, as this is not necessary. Sometimes it is dried by mistake, and sometimes it is stored too long. This should be carefully avoided, several bad losses having occurred from the

spontaneous ignition of nitrated cotton. It is the usual practice, and one that is advised to keep all dry or nitrated cotton in as small lots as is convenient. Boxes of wood, or better still, of fibre, should be used to store it in, or to transport it from room to room or building to building. Metal cans or cases should not be used.

The nitrated cotton is next taken to the mixing house, where it is mixed with alcohol, amylacetate, benzole and other similar chemicals which will dissolve the cotton. The dissolved nitrated cotton forms a pasty mass called "jelly." This material is very inflammable, and gives off inflammable vapors at ordinary temperatures. It should be carefully handled, and kept in small lots in covered receptacles. This building is usually equipped with a fan to drive out the inflammable gases. As under some conditions the cotton is explosive, and the solvents used are very inflammable, this building or section should be carefully safeguarded. It should be of fire-resisting construction, and subdivided into as many fire sections as practicable. Steam piping should be carefully located where it can not come in contact with the cotton, and electric lights the only artificial lights allowed. Metal covers should be provided for all vessels containing any inflammable materials.

The "jelly" is then taken to another section where it is mixed with clay, castor oil, coloring matter and other ingredients, to make the coating mixture, but as the "jelly" is about the only hazardous material in the room no particular precautions are necessary other than outlined above.

THE COATING

is done in machines which first churn up the mixture to be applied, and then spread it on the prepared cloth by forcing it between rolls. The coated cloth is then run back and forth over the rollers in an enclosure which is kept at a high temperature by steam coils. The heat drives off all the volatile constituents of the coating mixture, and the coated cloth comes out of the machine with its surface partly set. This whole process is repeated until the desired thickness is obtained. These drying enclosures should be so arranged that the fumes which are inflammable can be removed by a blower system.

The entire coating machine is enclosed in wood, brick or metal enclosures. A sheet metal enclosure with numerous doors and traps seems best for all purposes. It is more permanent and tighter than wood, and much easier to build and to get into for repairs and cleaning than an enclosure of brick. They are usually lighted inside by electricity and equipped by either hand operated or automatic steam jet.

The surface of the product at this stage is smooth and dull. There are various finishes given it, depending on the use to

which it is to be put. As stated above the finishing consists of calendering and embossing, coloring and varnishing, and involves none but the very evident hazards.

The various inflammable fluids used are delivered in iron drums or in tank cars. As small amounts as possible should be taken into the buildings, and in any case not more than one day's supply should be kept in any building at one time. The main supplies should be kept in underground tanks, or in iron tanks on the surface of the ground at a safe distance from any building. If the pipe connections from these tanks are made to any building they should be so arranged that the liquids cannot flow by gravity from the tanks.

MODERN BRICK MILL CONSTRUCTION

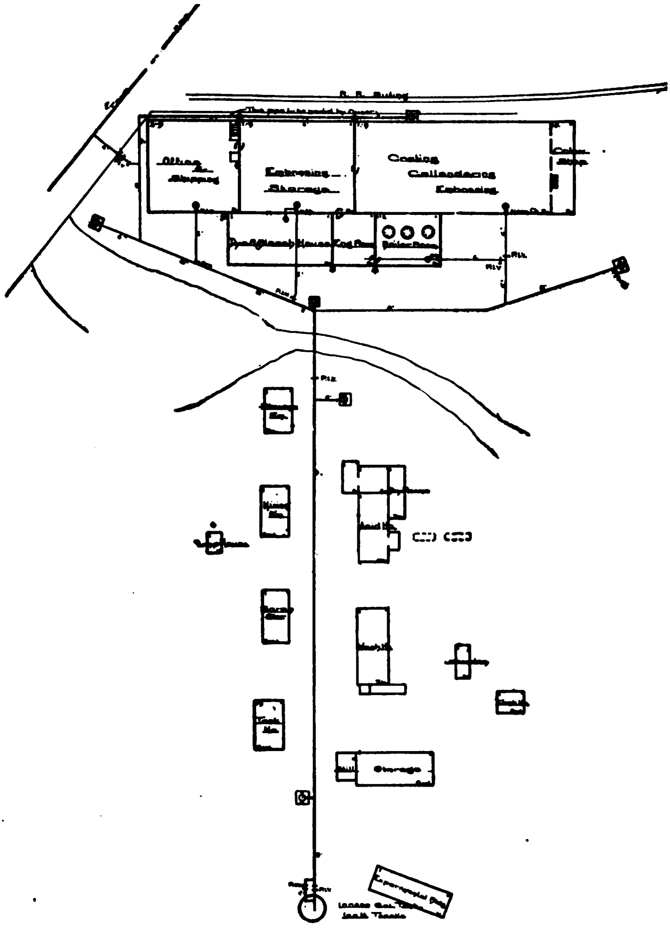
is satisfactory for most of the buildings of an artificial leather plant. The buildings having the mixing, nitrating and storage of "jelly" and celluloid scrap, if any, should be of fireproof construction. Areas should be as small as practical, and as stated above the very hazardous processes should be in separate buildings spaced about 50 feet apart. One of the illustrations shows a plant arranged in this way.

All the plant should be equipped with automatic sprinklers with proper water supplies. As all the buildings are usually heated air systems are not necessary, or are they advisable on account of the probability of flash fires. The dry rooms, picker trunks, under mixing tables and inside drying enclosure of the coating machines should be carefully equipped. Separate controlling valves are advisable for the sprinklers in the coating machines, so that the sprinklers can be turned off promptly without putting the rest of the system out of commission. Outside control by means of post indicator valves should be provided for the sprinkler systems, and at the sections where the more severe hazards occur they should be located at least 50 feet from the building.

An ample hydrant system should be provided with standard hose houses with proper equipment. The hydrants should also be carefully placed with reference to the dangerous sections.

The plant should be lighted by electricity. Of course the wiring should be done in accordance with the "national code," but care should also be taken that no switches or other apparatus which can flash or arc be placed in any of the sections where inflammable fumes or flyings are present.

A standard equipment of chemical extinguishers, fire pails for both sand and water should be provided, and a carefully laid out watchman system installed. The watchman should be instructed not to enter any dangerous rooms with his lantern, but to leave it outside and use electric lights if necessary when ringing up the stations in these portions.



ARRANGEMENT OF TYPICAL PLANT. NOTE FIRE SECTIONS AND DETACHED BUILDINGS.

As is true of any manufacturing plant, the buildings should be cleaned up regularly, and all rubbish removed. It is extremely important that the sections where the nitrated cotton is handled receive extra care as this cotton waste is very dangerous. The following are

BRIEF ACCOUNTS OF FIRES

occurring in risks of this kind:

(1) Fire occurred in the building known as mixing building. This is one of the detached buildings of the plant, being 25x40 feet, one story in height without basement. It is a wooden frame with corrugated iron inside and out. The building contains twelve automatic sprinklers on dry system. It is used for the mixing in power mixers, nitro-cellulose jelly, alcohol and benzole to form the coating which is used in this plant for the manufacture of artificial leather.

Fire started in one of the mixers shortly after it was put in operation for the day's work.

The superintendent says he thinks the fire was caused by a static electrical spark igniting the fumes. Six automatic sprinklers operated promptly, immediately checking the fire, and finally extinguishing it, confining damage to some belting and contents of two mixers.

This risk has recently been rebuilt, and great care has been taken in designing the present plant, so that if a fire should occur it would involve only a small value. To this end the plant has been cut up into numerous small fire sections, the hazards widely separated, and the whole carefully put under sprinkler protection. The experience of this fire seems to justify the outlay. The fire protection apparatus operated in a satisfactory manner, and the action of the employees was prompt and efficient.

The loss was under $500.

(2) A fire occurred at this plant at about 3 o'clock a. m., causing damage estimated at $2,000.

The watchman had just left the one-story building occupied for storage of celluloid scrap, when he heard a slight explosion and the whole structure burst into flames. All the eight sprinkler heads operated and held the fire after the celluloid had burned itself out. The windows were shattered, and the flames extended to mixing building, 40 feet distant, and damaged it slightly. It also scorched the fences, hydrant house and bridge for about 50 feet in all directions. The watchmen and volunteer fire brigade put on six hydrant streams and kept the fire from spreading.

The building where fire originated is one story, 21x35 feet, of tile walls, concrete floor and heavy roof, sheathed on underside with metal. The building is not seriously damaged beyond windows, doors, sash, etc., and some damage to roof.

The sprinklers saved it from a total loss. Cause of fire is unknown, and evidently came from some chemical reaction in the celluloid scrap stock. This is purchased from all points, and may contain anything from comb scraps to picture films. The watchman, as usual, left his lantern about 50 feet away, and went into the building to ring the station. The fire started before he got back to his lantern again.

(3) Fire started inside of drying inclosure of coating machine. Fumes ignited from the breaking of an incandescent lamp. Three automatic sprinklers extinguished the fire, with the assistance of one chemical stream from a large extinguisher. The fire communicated to the spreading table outside of machine and coating material ignited. This fire was extinguished by the attendant with a pail of sand. Loss slight.

(4) Fire occurred in the dry room caused probably by cotton lint around the steam pipes. The blower fan was stopped by the action of a fusible link, and a steam jet which was promptly turned on by an employee extinguished the fire with but slight loss.

(5) Fire was discovered in mixing house among wooden boxes containing batches of nitrated cotton in a partially dry state. The prompt action of three sprinkler heads extinguished the fire and wet down the nitrated cotton, thus preventing it burning, and extinguished the fire in and under the boxes themselves. Loss, $200.

A plant for the manufacture of artificial leather containing all the process and hazards above mentioned can be a very good fire risk. It would have to be carefully designed with this end in view, and properly protected, and the hazards well safeguarded. This, with good management, would result in a plant subject to small fires, but which could be easily extinguished with but small loss. One of the most important hazards to be looked for in these risks is connected with the drying and handling of nitrated cotton. A recently perfected process of nitrating, washing and dissolving the cotton without drying it completely eliminates several hazards. The water is replaced by alcohol, and the cotton never reaches the highly inflammable or explosive stage. Celluloid is, of course, a serious hazard, and principally on this account its use is being done away with. A plant in which these two hazards exist is not nearly as good a risk as one in which they have been removed.

CORK FACTORIES.

Gathering and Preparation of Raw Product—Its Manufacture into Articles of Commerce—Buildings and Machinery—Fire Hazards.

By Charles C. Dominge, Insurance Engineer-Underwriter, New York City.

If you will go the rounds of the various fire insurance offices and stand by the counter you will undoubtedly hear some energetic young "placer" employed by one of the brokerage houses say: "I want $5,000 on the —— Cork Works," and the usual answer given by the experienced counterman or underwriter will be: "This company will not touch it with a 40-foot pole." And why is this? Cork works have been a very unprofitable class for the companies, the loss in most cases being total. Statistics prove that a great majority of the fires are caused by foreign material entering the grinders, creating a spark and igniting the cork dust which is in a finely divided state scattered on the beams and side walls. This dust when a fire starts causes an explosion which is powerful enough to lift an ordinary roof and destroy the exterior walls of the building.

CORK

is the light, porous, elastic outer bark of the cork oak or tree indigenous to southern Europe and northern Africa. The cork tree is not of great size, generally 20 to 40 feet high, much branched with ovate oblong evergreen leaves. The acorns are eatable and resemble chestnuts in taste. The bark on trees or branches from three to five years old acquires a fungous appearance, new layers of cellular tissue being formed, and the outer parts cracking from distension until they are finally thrown off in large flakes, when a new formation of the same kind takes place. Cork intended for the market is generally stripped off a year or two before it would naturally come away and the process is repeated at intervals of six or eight years. The bark of young trees or branches is practically useless and it is only after the third peeling that good cork is produced. The removal of the cork being not the removal of the whole bark, but only of external layers of spongy cellular tissue, all or the greater part of which has ceased to have any true vitality and has become an incumbrance to the tree, is so far from being injurious that when done with proper care it rather promotes the health of the tree, which continues to yield crops of cork for over a century.

In stripping off the cork longitudinal and transverse incisions are made to the proper depth and each piece is then cut away from the tree by a curved knife with two handles.

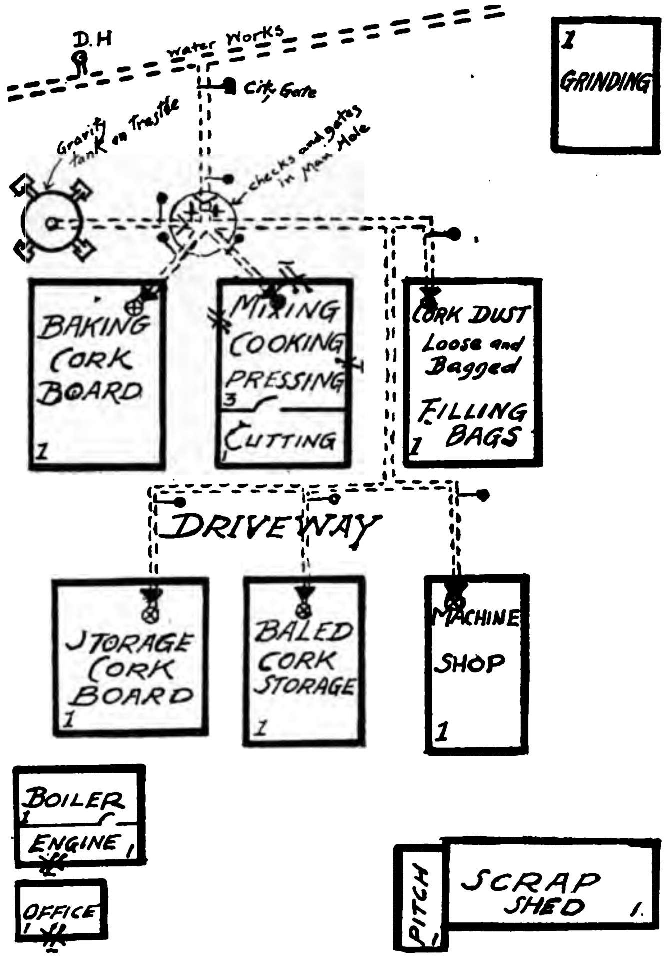
TREATING THE CORK.

The pieces are soaked in water, pressed flat, dried and superficially charred to remove decayed parts and conceal blemishes before they are packed in bales for the market.

Cork is used for many purposes, including cork discs for bottle stoppers, refrigeration warehouse insulation (it being far more preferable than sawdust), tips for cigarettes, in the manufac-

Branch of Cork Tree.

ture of linoleum, etc. It is much used on account of its lightness for life preservers, floats for fishing nets, etc., and on account of its impermeability to water and of its being a slow conductor of heat inner soles of shoes are made of it.



PLAN OF A MODERN CORK FACTORY. FIRE RESISTING CONSTRUCTION AND AUTOMATIC SPRINKLERS IN MAIN BUILDINGS.

The hazardous buildings where the cork is ground, and where scrap is kept, are furthest from the main buildings, and are not sprinklered, owing to the possibility of an explosion crippling the entire system.

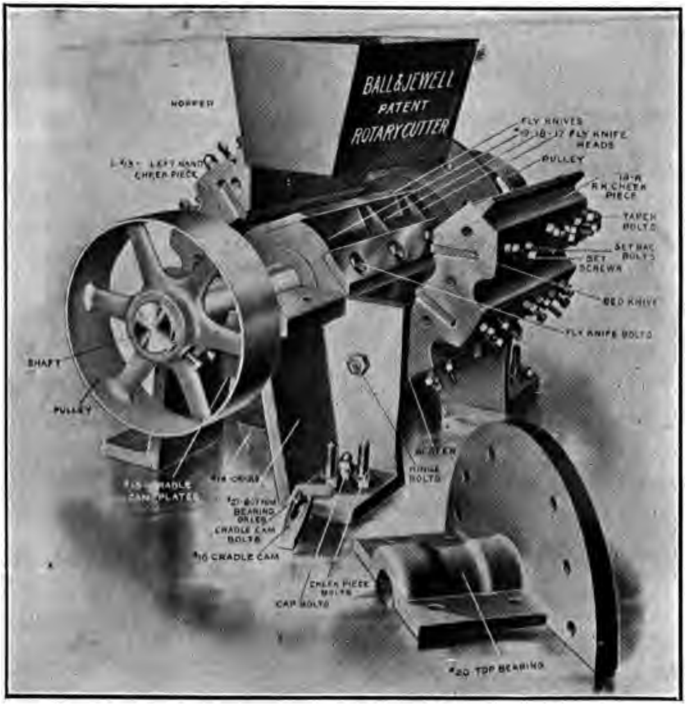
should be erected in an outlying section of the city, provided the water supply is adequate. All buildings should be of non-combustible material (i. e., common brick or reinforced concrete) and have light corrugated iron roofs, with ordinary glass skylights on metal frames with metal louvered sides for ventilation and proper screens over the glass. The ordinary glass in the skylight would allow the flames to get out of the building while the screen above would prevent the flying embers from the adjoining buildings entering the roof. The side walls should be as heavy as possible, not less than 12 to 16 inches. The height, especially where the grinding, crushing or where scrap is kept, should not be over one story. As far as possible no windows should be in the side walls (the skylights to furnish the light), but if windows are necessary they should be wired glass in hollow metal frames. All doors to be of standard lock jointed pattern, and arranged to be automatic. Automatic sprinklers to be installed in all the main buildings. (See sketch.)

MANUFACTURING COMPOSITION CORK BOARD.

Waste or scrap cork is received in bales, sorted and then fed by suction through metal pipes into high speed grinding machines or revolving knives (see sketch) from which it is drawn by suction through outside metal blower pipes to cyclone dust separators on the roof, the dust from which is sized and bagged, and then removed from the premises and sold to manufacturers of linoleum. The clean ground cork passes from the dust separators to steam heated mixers (similar to dough mixers), where high melting point pitch is added. This pitch melts at about 190 degrees Fahr. After the cork is properly mixed it is placed in a steam heated cooker, then the material is dropped to iron, air cooled pressing molds, after which the edges are trimmed by saws, sometimes a planer being used to smooth the tops and bottoms.

Ordinary cork board is made of ground cork without any other addition. Natural cork contains a resin, which can be drawn out by application of about 500 degrees Fahr. of heat, at which temperature the cork will char. Briefly the process is: Ground cork fed by a blower system enters overhead bins and is finally lodged in a hopper, after being passed through a steaming box. It is then allowed to fall by gravity into steam heated hydraulic pressing molds (consisting of iron frames with portable tops and bottoms) which compress the cork into a solid mass as the molds have a very high temperature. From the molds the cork is conveyed by iron tracks or iron roller gravity carriers which pass through long brick baking

ovens (heated by coal, producer gas or coke) well set and of substantial brick construction. The ovens are similar to the "leer" in a glass works. After baking for several hours the



ROTARY CORK CUTTER OR GRINDER.

This machine has from twelve to sixteen blades or knives, part of which are stationary and part revolving. They reduce the cork to uniform fineness.

cork passes out of ovens and is then removed from the molds, planed and sawed, and is then ready for shipment.

CORK DISC BOTTLE STOPPERS.

The cork is received in a ground state; it is then mixed in

an agitator with a hot mixture of glycerine and a vegetable gum (similar to gum arabic), then put in a steam heated kettle and mixed with paraffine, pressed by hydraulic machines into blocks baked in gas heated ovens, and then cut into thin sheets by power saws, and the discs finally punched out by special machines.

BOTTLE CORKS.

The cork bark is received in large irregular pieces varying from 1 to 3 inches in thickness and is cut into cylindrical shaped pieces by die cutters, trimmed and shaped in machines fitted with circular cutters. The machinery consists largely of numerous high speed circular and revolving die cutters.

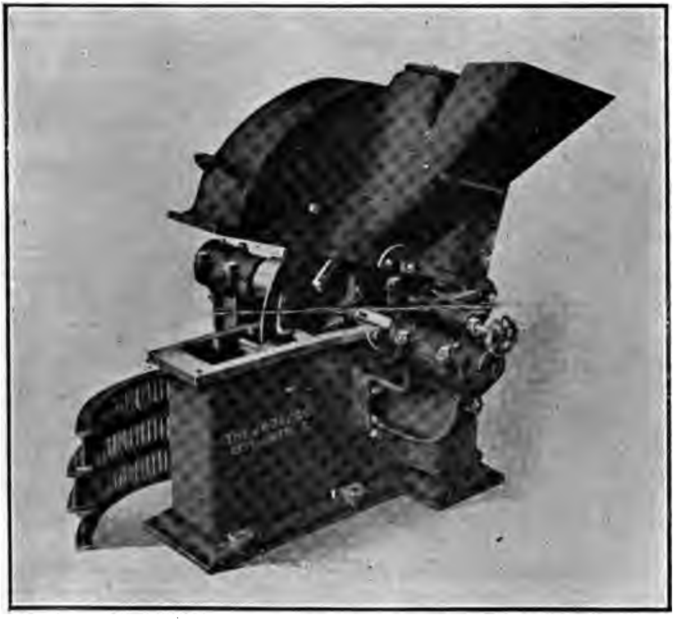
CORK GRINDING

is undoubtedly the greatest hazard in a cork works. The grinding feature is known under many "aliases," such as disintegrating, pulverizing, granulating, cutting, etc., but to the insurance man they all mean practically the same thing, only that one operation may grind the cork finer or coarser. Crushers and pulverizers as the names imply, render the cork almost in a powder state, and are therefore the most hazardous machines used. If scrap cork is used great care should be exercised to see that no pieces of iron hoops or other metallic or similar hard foreign substances which would be likely to strike a spark while passing through the mill, get in with the cork. The scrap cork is dried by hot air and then cleaned by an air blast which frees the cork from any heavier or foreign matter. Some factories merely use screens, which separate the cork from other foreign material. The cork is then conveyed to the hopper of the mills from which it is fed to iron inclosed burr mills. After grinding, it is conveyed to the bag room by screw conveyors in a metal chute, where it is caught in bags and removed to the ground cork storehouse or open stone walled pit to cool, generally about twenty-four hours.

SOME SAFEGUARDS.

The grinding should always be done in a building or section of good fire resisting construction, properly vented and cut off by automatic fire doors. As much heat is produced by friction in grinding (especially during the month of May, the atmosphere being peculiarly favorable for heating), the mills should either be kept cool by a spray of water or provided with water jacketed bearings. The mills should be entirely of iron construction and be provided with magnets and a "banking arrangement" under the rollers (similar to a malt mill in breweries) in order to smother a spark, should any foreign matter enter the rolls. The mills should run true and all bearings should

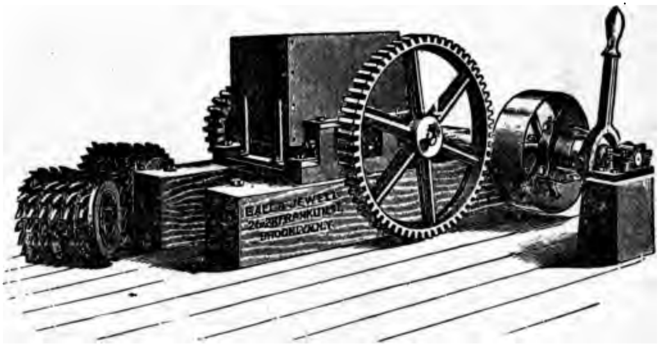
be accessible for examination, oiling and cleaning and kept free from dust as much as possible. In conveying the cork from one set of apparatus to another, conveyors, blowers and spouts should be of metal, as this method offords one of the best means of extinguishing a smoldering fire in the ground cork (due to a spark or the overheating of the mill) by depriving it of the air needed to support combustion. The heat itself generated during the grinding of the cork may set fire to it. In some plants the end of the chute to the bag house is open



LIGHTNING DISINTEGRATOR FOR GRINDING CORK.

The grinding is done in this machine by hardened steel beaters, riveted securely on a steel disc. These revolve on the face or feeding side of the mill between corrugated rings. The beaters catch the material as it enters the mill, and beat it against the corrugates until it is fine enough to pass between the disc and the face of the ring; when it passes here it is on the discharge side of the mill, and all that is fine enough is immediately driven out by the beaters on the back of the disc. What is not fine enough to discharge is caught by these back beaters and driven against the screens until fine enough to pass through.

and opposite an opening in the wall to give vent in case of a spark being struck in one of the mills and carried over the bagging room. No open lights should be allowed, the standard calling for dust-proof electric light inclosures with outside switches. The room should be cleaned regularly and smoking should be positively prohibited.



SECTIONAL CRUSHING ROLL.

The rolls proper are made of chrome steel or chilled cast iron, and are simple in construction, being composed of a number of sheaves with teeth on their faces. The rolls can be adjusted to crush the cork very fine, and can be provided with a dust-proof casing.

Cork is not subject to spontaneous combustion, but extreme care must be taken to see that the burlap covering is clean and that no foreign substances appear in the bales likely to cause a spark by friction when being shifted about. Scrap cork and pitch should not be stored in the driveways or between the various buildings (see plan).

GOODS MADE FROM CORK.

Spanish black, used by painters, is made by burning cork in closed vessels and the parings of cork are carefully kept by cork cutters for this purpose.

Cork cement consists chiefly of crude shellac and wood alcohol.

Cork putty consists of asphalt, cork and non-hazardous oils.

Cork leather, which is waterproof and very elastic, is cork powder consolidated with india rubber.

BLEACHING CORK.

The chief ingredients used in the bleaching of cork are oxalic acid and chloride of lime.

BRANDING CORK.

The cork is fed to the branding machine through a hopper and branded by a die heated by a gas flame as the cork passes through a narrow passage.

THE FIRE RECORD.

Most fires in this class are caused by the grinding mills, although sometimes the corners of the cork blocks become ignited while passing through the dryer. The odor of burning cork is very pungent. Sometimes fire will enter the baled cork to a depth of 6 or 7 inches, extract all the resin and reduce the bale to a light charred mass, resembling coke. Cork burns with great intensity, emitting enormous quantities of suffocating smoke, making it very hard for the firemen to approach and owing to its lightness the burning cork has been known to travel many miles in the air.

THE DUST HAZARD.

Cork dust is of a highly dangerous character (explosion risks) owing to its extreme fineness and capacity for remaining suspended in the air for a long time. If an approved blower system is installed as follows: "The exhaust pipes from the various buildings should enter a 'header' system, and where they enter the header they should be provided with steam jets, taking steam from the exhaust of the fan engine," the entire room kept clean and properly vented and with no open lights and sufficient chemical extinguishers (using carbon tetra-chloride as its base), this important hazard will be reduced to a minimum.

If no direct fires are permitted and all heating apparatus properly set and the various hazards segregated, together with the construction and fire protection taken care of as suggested, the underwriter will have little to worry him if he will write a conservative line.

REFRIGERATION.

History of Development—Processes, Ancient and Modern—Special and Incidental Hazards.

By William J. Tallamy, Inspector.

Like most scientific achievements, the practice of artificial refrigeration is directly due to a great natural law. As water always tries to find its level, so also do heat and cold try to balance and equalize. For example, if a cold and a hot body or substance were to come in contact with each other an immediate change would take place; the cold body gradually absorbing the heat from the hot body would get warmer, while the hot body in parting with its heat would gradually cool, until the temperature of both is the same. Briefly stated, this is the fundamental principle of artificial refrigeration.

As far back as the year 400 low temperatures were attained by a liquefaction process; the refrigerant being formed by the fusion of various salts in water, or by the mixture of cracked ice, snow and common salt. Temperatures below 32° Fahr. were maintained with these solutions.

THE VACUUM SYSTEM.

The first efforts to produce refrigeration by mechanical means appear to have been made about the middle of the 18th century. when Dr. William Cullen, a Scotch physician discovered that by forcing the evaporation of water a certain amount of its latent heat is removed. In the year 1755 he invented a vacuum refrigerating machine consisting of a sealed vessel containing a certain amount of water and air, with a vacuum or air pump connection. The air in the vessel was removed by the air pump, creating a vacuum and causing a certain percentage of the water to evaporate, the heat necessary for evaporation being taken from the water itself. As the vacuum was increased, the temperature of the water was reduced until it reached a freezing point.

Some years later a similar machine was made in which the vapor from the water was absorbed as removed by a concentrated sulphuric acid. This was the first mechanical refrigerating machine used with commercial success. Though similar machines were used more or less throughout the 19th century and even within the past few years, their success was very limited because of the corrosive action of the sulphuric acid on the metal parts of the machines, it being almost impossible to maintain tight joints any length of time.

of refrigeration is distinctly an American invention, the first machine meeting with success being invented by Dr. John Gorrie of Florida about the middle of the nineteenth century.

While it has a distinct advantage over other refrigeration systems now in use, inasmuch as no dangerous chemicals are necessary in its operation, it is gradually becoming obsolete largely because of its bulkiness and poor general results as compared with modern systems using volatile liquids.

It is especially well adapted, however, to marine work and atmospheric cooling for which it is still used to some extent.

Air is converted into a refrigerant by a very simple process, bringing into play another of nature's laws. Air in its natural state contains a certain amount of latent heat. When it is under compression this latent heat is intensified to such an extent that it can be easily removed. In the absence of this heat, air can not return to its natural state, which it is prone to do when released, until it has absorbed an amount of heat equal to that removed during compression.

The function of the cold air machine, therefore is to reduce air to an unnatural state by compressing it and removing part of its latent heat, after which, the air in expanding becomes a natural refrigerant.

Great difficulty was met with in the early use of cold air machines, due to the moisture which would collect and freeze in the pipes, valves and fittings, and clog the system. This was eventually evercome by subsequent improvements designed to relieve the compressed air of its moisture before it entered the expansion chamber.

Most cold air machines though larger, are not unlike an ordinary double acting air pump in general appearance. In operation air is pressed to about 50 lbs. per square inch, the temperature being increased in proportion. The heat of compression is absorbed and carried off by the running water in the jacket coolers surrounding the air tubes. The compressed air, though reduced to a temperature slightly above normal, still retains its moisture which is removed by allowing the spent cold air on its return to the compressor from the refrigerator to circulate round the pipe containing the compressed air on its way to the expansion cylinder.

The expansion chamber generally resembles the compression cylinder in appearance and is so arranged that the air in expanding helps run the compressor. The air leaves the expansion cylinder at a very low temperature and is conducted to the room to be cooled where it enters through an opening near the *ceiling.* drops to the lowest level, gradually rising as it becomes

heated until it finds its way to the outlet, usually at the opposite end of the room. It is then drawn back to the compressor and when properly mixed with fresh air recompressed and forced through the same cycle of operation as before.

VOLATILE LIQUIDS AS REFRIGERANTS.

At the present time artificial refrigeration is produced largely by the use of volatile liquids as the cooling agents. The first machine designed to produce refrigeration with the use of volatiles was made in the year 1834. This machine was of the compression type, and is historically considered the origin of all refrigeration machines operating on the compression principle. The compression system of evaporation has been revolutionized since then, and is now by far the most popular.

During the latter half of the nineteenth century many volatile liquids were used as refrigerants experimentally and commercially; such as ether, gasoline, rhigoline, naphtha, ammonia, carbon dioxide, sulphurous acid, mixtures of ether and sulphur dioxide, etc.

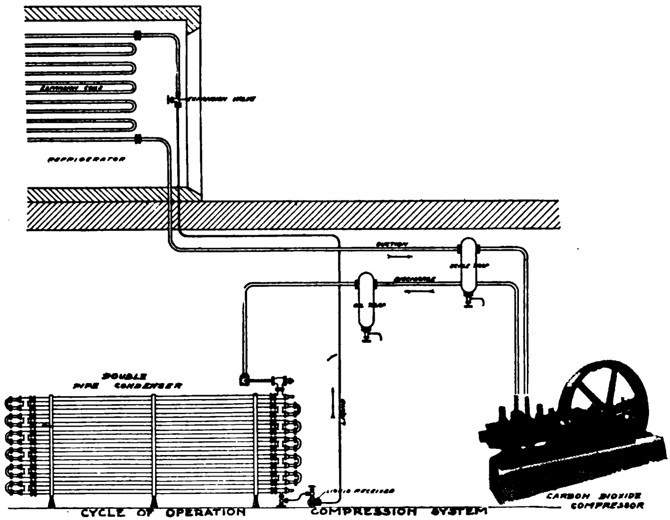


FIG. 1.

The use of most of these has been abandoned, except perhaps in occasional laboratory work, largely because of their dangerous

natures, and the grave possibility of serious explosions, fires and other accidents that might result were they more commonly used.

All volatiles will, of course, boil or vaporize at ordinary temperatures and in so doing they absorb what is known as their latent heat of evaporization or the heat necessary to convert the liquid into vapor.

As heat is necesary to convert water into steam, so also is heat necessary to convert volatile liquids into vapor or gas, though there is a wide difference between the respective amounts of heat necessary.

For instance, the boiling point of water is 212° Fahr.; while that of ammonia is 28° below zero, the difference between the boiling temperatures of both being about 240°.

As a pressure is generated at the expansion of water into steam, so also is pressure generated when volatile liquids are converted into vapor.

When volatiles vaporize in open air, the latent heat necessary is taken from the atmosphere and under ordinary conditions its loss and the pressure generated are not felt. But if the vaporization takes place in a closed room, the latent heat will be taken from its contents, and the pressure in the room will gradually rise. When a volatile is vaporized, it is changed from a liquid to a gas, chemically known as ordinary gas.

All ordinary gases can be restored to liquids if relieved of their latent heat of evaporization while under sufficient pressure.

In present day refrigeration the gas is placed under the necessary pressure for condensation in two different ways; one being by mechanical compression, a power compression pump being used to force the gas through a series of iron piping under certain pressure. The other method is sometimes referred to as a chemical process, the pressure being induced by boiling a solution of aqua ammonia at a high enough temperature to expel the ammonia under a pressure sufficient for condensation. The latter method is used in the so called absorption system which will be described in detail later on. In refrigeration practice the latent heat of ordinary gases under pressure for condensation is removed with the use of running water at or below ordinary temperature, the water coming in contact with the surface of the pipes containing the gas.

THERE ARE THREE VOLATILES COMMONLY USED

as refrigerants at the present time: Anhydrous ammonia NH^3, Carbon dioxide CO^2, commonly known as carbonic acid, and Sulphur dioxide SO^2.

Of the three, anhydrous ammonia is by far the most popular, being used in both the compression and absorption systems.

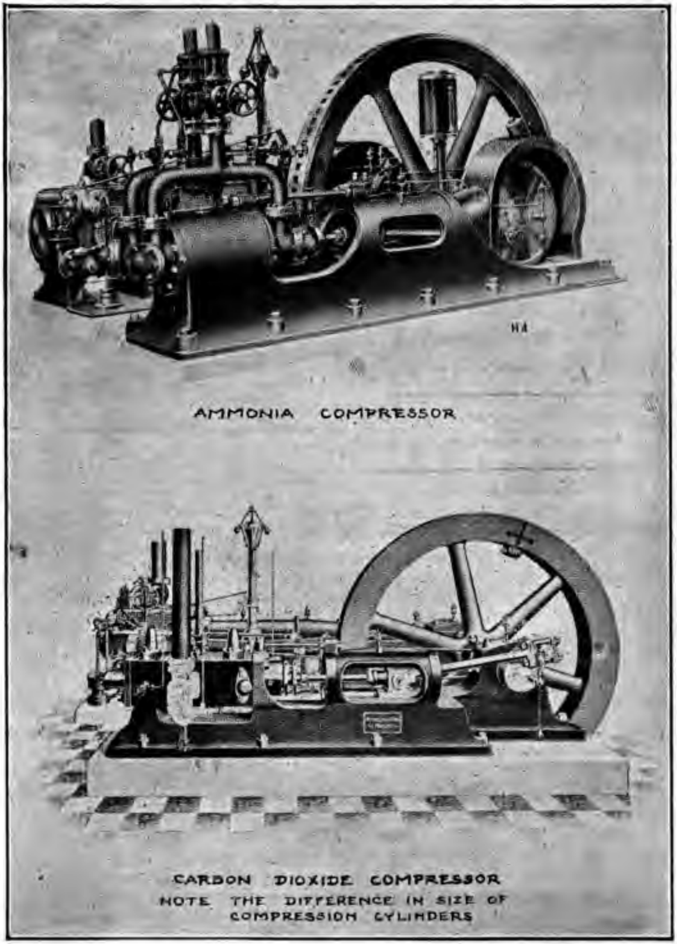

AMMONIA COMPRESSOR
CARBON DIOXIDE COMPRESSOR
NOTE THE DIFFERENCE IN SIZE OF
COMPRESSION CYLINDERS

FIG. 2.

Carbon dioxide is next to ammonia in popularitiy and its use is rapidly increasing in view of its decided advantages over the others as will be seen later on. Sulphur dioxide is little used in comparison with the others being practically confined to small equipments suitable for dwellings, small hotels, clubs, etc.

Anhydrous ammonia (NH^3) or pure ammonia is a colorless irrespirable gas with a disagreeable pungent odor of a highly suffocating nature. It is not inflammable under ordinary conditions, being composed of one part nitrogen, in weight 82.4 per cent. and three parts hydrogen, in weight 17.6 per cent.

The nitrogen gas, the largest constituent by weight, will not burn or support combustion. Hydrogen will burn and has explosive tendencies when properly mixed with oxygen or air. This can only occur when the temperature of the ammonia is raised to or above 900° Fahr., when the gases of which it is composed separate. The hydrogen thus liberated will burn if ignited by spark or flame, and might form explosive mixtures with air or oxygen providing either is present in the proper portion. Some authorities claim that ammonia gas when properly mixed with air will explode, while others claim the reverse. At any rate such a mixture in a refrigerating establishment is a very remote possibility, owing to the fact that ammonia gas is much lighter than air from which its tendency is to separate rather than mix. It has been clearly demonstrated in practice that ammonia in any form under ordinary conditions will act as an extinguisher rather than a supporter of combustion.

Ammonia has a tendency to form inflammable mixtures with oils used in ammonia compressors for lubricating, sealing and cooling purposes. Fires have been caused when such mixtures, liberated by a break at or near the compressor, have come in contact with an open gas or other light in the engine room. Open lights should therefore be prohibited in the engine room of refrigerating plants.

Cylinders of ammonia have been known to explode when exposed to high temperatures, due to the expansion of ammonia when heated.

For this reason cylinders of ammonia should be kept in a cool place, and never left in the boiler or engine rooms where high temperatures are common.

Ammonia will corrode metals composed in whole or in part of brass, copper or nickel, but apparently does not attack iron or steel; therefore iron and steel should be used exclusively in ammonia equipments.

Carbon dioxide (CO^2) is a colorless, odorless gas composed of one part carbon and two parts oxygen. It is incombustible, will not support combustion and has a tendency to prevent explo-

sions when mixed with certain hydrocarbon explosives. It does not attack metals or food products with injurious results, it being commonly used to produce effervescence in mineral waters, beer and other liquors.

It is heavier than air, having a specific gravity of 1.529 as compared with air, and liquefies at 124° below zero.

As a refrigerant it has many distinct advantages over ammonia, as can be readily seen in the above. Its one disadvantage, however, is in the heavy working pressure necessary throughout the system as compared with that of ammonia. This is due to the very low boiling point of CO^2. The working pressure in carbonic acid systems is usually 300 lbs. to 1,000 lbs. per square inch, while that of ammonia systems is 30 lbs. to 250 lbs. in extreme cases, the average being 30 lbs. to 170 lbs. per square inch.

While the working pressure in carbonic acid gas systems is much higher, the cooling action is equally greater. In other words a carbonic acid machine will do six times as much work as an ammonia machine of equal size, therefore the equipment for the same amount of refrigeration is much smaller.

All refrigeration equipments are now so carefully tested before being put in commission that there is little danger of breaks or ruptures due directly to their working pressure. Ammonia systems are usually tested at 500 lbs. pressure, while the maximum working pressure is estimated at 250 lbs. Carbonic acid systems are tested at 2,500 lbs. pressure, while the working pressure seldom exceeds 900 or 1,000 lbs.

Another great advantage the carbon dioxide systems have over those of anhydrous ammonia is in their comparative danger to life in case of an accidental break in the equipment causing the volatile to be released in the presence of employees, or firemen in the event of a break resulting from fire. It is estimated that a mixture of less than 1 per cent. of ammonia in air would prove fatal in less time than a 6 per cent. mixture of carbon dioxide in air.

As ammonia equipments are necessary six times as large as those of carbon dioxide for the same refrigerating capacity, the amount of ammonia in the system would be six times as large.

It can, therefore, be readily seen that the dangers from this point of view are infinitely greater with ammonia than they are with carbon dioxide.

Sulphur dioxide or sulphurous acid (SO^2) is a non-inflammable colorless gas, composed of one part sulphur and two parts oxygen. It is made by burning sulphur in oxygen or dry air and has a pungent suffocating odor. It is soluble in water which will absorb 40 to 50 times its own volume of acid, and has a tendency to extinguish fire.

As its boiling point is 14° Fahr., it is convertible into a refrigerant at a low working pressure; but owing to the bulkiness of its equipments as compared with ammonia and carbon dioxide equipments of equal capacity it is not well adapted to other than small equipments. The chief danger in using sulphur dioxide as a refrigerant lies in the highly corrosive influence it has upon metals when exposed to air, making it almost impossible to maintain tight joints.

THE COMPRESSION SYSTEM

of refrigeration is divided into three sections, namely, the compression, the condensing and the expansion sections.

In order that the cycle of operation be made continuous, these three sections are connected with each other by iron or steel pipes, valves and fitings, the same refrigerant being used over and over again, going progressively through the process of compression, condensation and expansion; additional supplies of the refrigerant being necessary to replace trifling losses as they occur through leaks, etc.

The compression section consists of a compressor which acts as its name implies, compressing gas until it is under pressure of 130 to 170 lbs. in ammonia systems, and 300 to 900 lbs. in carbon dioxide systems, then forcing it through the connecting pipes and fitting to and through the condensing section or condenser, and on to the inlet of the expansion section. While passing through the condenser the gas is converted into a liquid but the pressure is maintained to the inlet of the expansion section. The compressor also maintains a section or back pressure of 25 to 30 lbs. at the outlet of the expansion section where it gets its supply of gas, performing a continuous cycle of operation by drawing the spent or hot gas from the expansion section, compressing and forcing it back through the condenser.

The compressor (see Fig. 2) is not unlike an ordinary air pump in general appearance, with its cylinder, piston, inlet and outlet pipes, valves and etc. They vary in detail, according to their make, but the general result in action is the same. They can be operated directly or indirectly by steam, electricity or any other motive power, steam where available being generally used. There are two distinct types, the single acting, which compresses gas at one end of the cylinder only at every other stroke, and the double acting machine which compresses gas at both ends of the cylinder, compression being done at every stroke.

MANY FIRES HAVE BEEN CAUSED

by accidental breaks at or near the compressor, such as the knocking off of cylinder head, rupturing valves and fittings, and bushing gauges, which allowed the gas charged with a fine spray

of lubricating oil to be pumped into the engine room where it was ignited by an open light. In most modern equipments this danger has been practically eliminated by the installation of safety devices, such as spring adjusted cylinder heads in the compressors, and automatic check and relief valves at the glass gauges and other parts where trouble is likely to occur.

In compressing gas, heat is generated. This heat is partly removed in the compressor. Most machines have water jacketed cylinders, the heat being absorbed and carried off by running water in the jacket. Other machines work with gas in a saturated or partly liquified state, the gas absorbing some of the heat of compression. Another method of removing heat in the compressor is by injecting mineral oil into the cylinder at each stroke of the piston, the oil absorbing some of the heat generated. A certain amount of oil, usually a mineral paraffine oil, is injected into the cylinder of all compressors for lubricating and sealing purposes.

In order that refrigeration may be continuous and automatic, certain special valves, fittings and attachments are necessary. Owing to the heavy working pressure, these valves and fittings are bolted together, the seats resting on gaskets made of rubber, paper, lead or other suitable material, to insure tight joints.

It is impossible to prevent some of the oil injected in the compression cylinder from mixing with the gas and entering the refrigeration pipes the presence of which would seriously interfere with the efficiency of the system, if it were not removed.

This is done by an oil trap, placed between the compressor and the condenser which acts as a separator, removing the oil from the gas as it comes from the compressor. This oil trap is a cylindrical shaped device fitted inside with baffle plates so arranged that the gas in passing through to the gas outlet is obliged to take a zigzag course arount the baffle plates on which it deposits the oil. The oil as it accumulates gradually finds its way to the bottom of the trap where it is removed.

AFTER LEAVING THE OIL TRAP

the gas enters the condenser. The condenser's function is to rid the gas of the heat of compression still retained by the gas, and reduce it to a liquid. The temperature of the gas as it enters the condenser is usually in the neighborhood of 200° Fahr. In order to produce condensation the temperature of the gas must be greatly reduced which in conjunction with the pressure maintained by the compressor, causes the gas to liquefy and pass on to the receiver.

There are three common types of condensers in use at the present time, the double pipe, atmospheric and submerged con-

densers, named in the order of their popularity, each being cooled by running water.

The double pipe condenser consists of coils of double iron pipes one within the other, the inner pipe usually 1¼ inches and the outer pipe 2 inches in diameter. The water passes through the smaller pipe in opposite direction to that taken by the hot gas which is contained in the annular space between the water pipe and the inner surface of the larger pipe. The water entering at the bottom passes out at the top near where the gas enters; the hot gas meeting the warmest water first gradually works its way downward through the condenser pipes, the surface of the water pipe with which it comes in contact gradually getting colder, until the gas becomes saturated and condenses, leaving the condenser in liquid form at outlets at some of the bends and the bottom.

The atmospheric condenser is one probably more conspicuously common because it is usually placed in slatted enclosures or open on the roofs of high buildings. It consists of coils of pipes mounted in an upright position over which water trickles from a perforated pipe or trough located over the top coil. It is called an atmospheric cooler because the air circulating around the coils assists the water in cooling the gas.

The direction taken by the gas and water here are also opposite, the hot gas entering the bottom coil gradually rising as it passes through the coils until it condenses and runs off at outlets provided at the bends of the coils. The water flowing over the coils gravitates to a drip pan or drain.

THE SUBMERGED CONDENSER

is one in which the pipes conveying the gas, arranged side by side are immersed in a tank containing running water. The hot gas entering the coils at the top, condenses and then passes out as liquid at the bottom. Water enters the tank at the bottom, running off through an opening at the top.

A purging cock is usually placed on the top coil of all condensers through which air and other gas condensations can be removed.

Atmospheric and double pipe condensers are usually 18 to 24 coils high, and 20 feet long. The coils are arranged to drain. In some condensers the liquefied gas is retained in the lower coils, doing away with the liquid receiver.

In most cases, however, a special liquid receiver is used, consisting of a cylindrical shaped iron tank, which receives the liquid from the condenser, supplying it to the expansion chamber or coils as it is needed. Receivers are generally provided with glass gauges showing the amount of liquid they contain. These gauges in modern equipments are provided with automatic check

valves which automatically close if the glass is broken, thereby preventing the liquid refrigerant from escaping.

The expansion section of refrigerating equipments is very simple, consisting generally of coils of 2 inch iron piping arranged side by side usually in a horizontal or vertical position. At the entrance of the expansion coils is an expansion valve, which is so constructed as to be capable of very fine adjustment. The expansion valve (see Fig. 3) used in refrigeration is usually of the needle valve type controlled by a wheel on the projecting end of the stem. Some concerns use an automatic expansion valve which is accurately controlled by a patented automatic device.

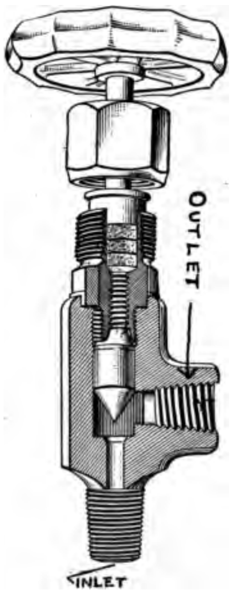


FIG. 3.

As the liquified gas passes through the minute opening in the expansion valve under the heavy pressure maintained by the compressor, and enters the expansion coils where the pressure is never sufficient at the existing temperature, to maintain the gas in liquid form, it immediately vaporizes and and gasifies, absorbing the heat necessary from the substances surrounding the expansion coils.

As the gas forms in the expansion coils, it is withdrawn by the compressor through its suction pipe to be recompressed as before.

There are in general practice three different methods of utilizing the cold thus produced, namely, by direct expansion, brine circulation and cold aid blast. With direct expansion, the expansion coils are placed in the refrigerator or room to be cooled, the heat of expansion being absorbed directly from the contents of the room. This method is very popular, and is generally used when low temperatures are desired. From a fire insurance point of view it is less desirable than other methods because of the damaging effect the ammonia fumes would have on the perishable contents of the refrigerator, and the difficulty fire fighters would have in handling the fire in the event of a break in the piping caused by fire.

THE BRINE CIRCULATING METHOD

is also very popular, especially where higher temperatures are

desired. Brine, usually a 20 to 25 per cent. solution is placed in a tank in which the expansion coils are immersed; the brine when sufficiently cooled is forced through pipes in the refrigerator or cold storage room.

When the cold air blast system is used, the expansion coils are usually placed in an enclosure through which there is a constant circulation of air. The air is taken from the room to be cooled by a large fan, forced over the coils and back to the room.

In the direct expansion and brine systems, the refrigerating coils are usually placed side by side on iron racks or hangers at the side or top of room, or in an enclosure with open ends or sides to insure proper circulation over the room. Coils should be properly spaced and kept at least 3 inches from the walls of the room to prevent the frost and ice which collects on the pipes from interfering with proper circulation of air around the pipes. Proper drip pans should be placed under the coils to carry off the drip from melting frost when the system is shut down.

The compression system of refrigeration in this country is largely confined to the use of anhydrous ammonia and carbon dioxide as refrigerants. In principle the systems are alike, the only difference being in the relative size of the compressors, and equipment and the necessary working pressure.

As sulphur dioxide is used in small equipments only, a brief mention here will be sufficient. One type of machine using sulphur dioxide resembles a large dumb-bell in appearance, consisting of two oval shaped chambers connected by a hollow shaft. These chambers are made of a bronze composition, one acting as the expansion, the other as the condensing chamber; the liquid and gas automatically passing from one to the other through the hollow tube.

The lower half of each chamber is immersed, one in running water, the other in brine.

The machine is charged under a vacuum, and the chambers sealed; one charge lasting indefinitely.

In action, the entire machine revolves usually with the assistance of a small electric motor. The sulphur dioxide expanding in the chamber partly immersed in the brine, cools the brine which is forced through pipes in the refrigerator. As the liquid expands into gas it passes through the hollow tube to the condensing chamber where it is cooled by the running water and condensed by two compressors mounted on the shaft passing through the centre of the chamber, and balanced by counter weights.

As the machine revolves the gas is condensed, passing through the connecting tube to the expansion chamber again.

of refrigeration is possible with such volatiles as have great affinity for and will readily mix with water, such as ammonia and sulphuric acid. In former years sulphuric acid was used in absorption systems to some extent, but owing to its highly corrosive tendencies its use has been practically abandoned.

Ammonia seems to be exclusively used at the present time. It has such great affinity for water, that water at ordinary temperature will absorb 700 times its volume in ammonia gas; the mixture being commercially known as aqua ammonia.

Unlike the compression system, no mechanical energy is necessary other than that of a small pump used to force the liquid from one section of the system to another; the office of refrigeration being brought about by chemical rather than mechanical means.

As in the compression system the process is continuous, the same refrigerant being used over and over again; small amounts being added to replace trifling loss through leaks as they occur.

The equipment in the absorption system consists of eleven vital parts acting in conjunction with each other. They are as follows: The generator, analyzer, rectifier, condenser, liquid receiver, expansion valve, expansion coils, absorber, pump, exchanger and weak liquid cooler.

The generator is a cylindrical shaped steam heated iron boiler or still, set horizontally on a suitable base, in which aqua ammonia usually a 26 to 30 per cent. solution is placed for distillation. It can be heated by direct heat from below, but steam is generally used as it gives better results, the heating coils being placed horizontally in the lower half of the generator.

When sufficiently heated the solution in the generator vaporizes under pressure. Ammonia having a much lower boiling point than water, the vapor given off in the generator is largely ammonia. As the ammonia is removed, the liquor in the generator becomes weaker and is withdrawn through a pipe opening at the bottom of the generator, which carries the weak liquor to the exchanger.

In addition to separating the ammonia from the water, the generator also provides and maintains sufficient pressure in the condenser to insure condensation. The temperature in the generator is usually in the neighborhood of 270° Fahr., which is the equivalent of 160 pounds pressure.

The analyzer is an iron cylindrical shaped shell placed directly above and attached to the generator. It acts as an outlet for the vapor as it leaves the generator, and an inlet for the strong liquor as it returns to the generator for further distillation.

The analyzer is fitted with a series of trays over which the strong liquor flows on its way to the generator. The hot vapor passing over the surface of the returning liquor heats and absorbs some of the ammonia, at the same time depositing some of the water contained in the vapor.

The rectifier is a condenser, cooled by running water, designed to rid the hot vapor of the balance of the water taken up by it in the generator. The vapor is practically converted into dry ammonia gas in the rectifier and passing on to the final condenser is reduced to a liquid.

The water removed from the vapor in the rectifier is returned to the generator through a pipe leading to the analyzer.

The rectifier and condenser in the absorption system are similar to the condensers as described in detail in the compression system, consisting of the atmospheric, double pipe and submerged types. The cooling required in the rectifier is much milder than that necessary in the condenser, however, warmer water being used over a smaller cooling surface.

ANOTHER FORM OF CONDENSER

sometimes used in absorption systems consists of an iron or steel cylinder containing coils of iron pipe through which cold water is constantly running. The hot gas enters at the top, condensing as it passes downward over the water pipes. This type of condenser is also used as the liquid ammonia receiver supplying the expansion chamber direct through the expansion valve.

If there is a separate liquid receiver its arrangement and function are similar to those of the compression system.

The expansion valve and coils are also similar to those previously described.

When the brine circulating system of cooling is used in the absorption system brine is frequently cooled in an especially constructed cooler, consisting of a cylinder containing a rich brine in which the ammonia expansion coils are immersed.

The pressure in the expansion coils of the absorption system is about the same as that of the compression system. The spent or heated gas on leaving the expansion coils is forced to the absorber under this pressure, usually about thirty pounds.

The absorber is a cylindrical shaped shell in which there are coils of iron pipes containing running water.

In the absorber the spent or heated ammonia gas from the expansion or refrigerating coils and the weak liquor from the generator are combined, the weak liquor absorbing the gas. The running water in the coils of pipe assists in the absorption by removing the heat of the solution. The colder the solution the more rapid and perfect the absorption. The gas and weak liquor both enter the absorber at the top, the liquor in the form of a *spray* meeting and absorbing the gas as it enters. As the gas

is absorbed the liquor becomes stronger with ammonia and is removed through a pipe opening at the bottom, usually by a small pump which forces the strong liquor through the exchanger to the analyzer through which it enters the generator.

The exchanger is the cylindrical shaped iron shell through which the weak liquor passes in iron coils of pipe from the generator to the absorber. The strong liquor immersing the coils of hot weak liquor in the exchanger absorbs part of its heat, while the hot liquor benefited by parting with some of its heat to the strong liquor passes on to the weak liquor cooler where more of its heat is removed. The temperature of the weak liquor after leaving the weak liquor cooler, usually a double pipe cooler, is sufficiently cooled to enable it to properly act as an absorber of gas in the generator.

In some systems the absorber and the exchanger are arranged similar to the double pipe condenser, the colder liquid passing through the inner pipe and the warmer liquid through the annular space between the inner pipe and the inner surface of the larger pipe.

As the temperature of the cooling or condensing waters used in the absorption system differs, the same water is frequently used throughout. The cold water first assisting in liquefying the gas in the condenser passes on to the absorber, where it assists in the aborption; it then passes through the weak liquor cooler and on to the rectifier where water at a comparatively high temperature is required.

FURTHER ECONOMIES

are practiced in the absorption system by the use of exhaust steam for heating the generator. In such cases oil traps should be installed between the generator and the source of exhaust steam supply.

The valves and fittings used in the absorption system are similar to those used in the compression system, with their bolts, gaskets, etc.

The hazards of the absorption system are milder than those of the compression system, especially as there is little or no danger of the presence of explosive mixtures of ammonia gas and lubricating oil in the system.

INCIDENTAL HAZARDS.

In addition to the numerous processes and hazards hitherto mentioned, there are the usual incidental hazards of the boiler and engine room usually present in connection with systems of artificial refrigeration, most of which require little special mention. Compressors are generally run by steam engines, though electric motors, gas and gasoline engines and water motors are sometimes used. When steam is used careful attention should

be given to the proper setting of the boiler and its smokestack.

It is highly desirable that the boiler and engine rooms be located in separate fireproof buildings, with double three-ply automatic lock jointed metal covered fire doors properly hung on each side of openings; especially in view of the fact that a slight fire in the boiler or engine room, if of ordinary construction, might result in crippling the refrigerating apparatus to such an extent that a consequential damage to perishable merchandise in isolated cold storage rooms would follow.

INSULATION.

Generally speaking, the purpose of artificial refrigeration is to provide and maintain low temperatures in a room by removing the heat from its contents. After the heat has been once removed it would not be necessary to continue operating the refrigerating machinery if it were not for the fact that the cold induced by the refrigeration not only attacks the heat in the room but is constantly trying to absorb the heat outside of the room through its walls and partitions. In order to check this the best known non-conductors of heat are used in the construction of all walls, floors and ceilings of cold storage rooms.

Some of the most popular insulating materials in use at the present time are cork blocks, ground cork, hair felt, mineral wool, cement, concrete, sawdust, paper, hollow tile and ashes. Still air cells or spaces form one of the best non-conductors of heat when properly used in conjunction with some of the above insulators, but care must be taken that the air is non-circulating. Cut No. 4 shows how some refrigerator insulating materials are installed to the best advantage.

USES.

So varied and numerous are the uses to which artificial refrigeration is put that it would be useless to try to name and describe them all in detail. A few of the more common uses are as follows:

In breweries it is extensively used in removing the heat of fermentation, in cooling wort, and in maintaining the necessary low temperatures in beer cellars and storage rooms.

Cold storage plants owe their existence entirely to artificial refrigeration. The apparatus in such establishments is so ably controlled that temperatures varying from 15° Fahr., necessary for freezing game, poultry, etc., to 55° Fahr., necessary to properly preserve tropical fruits, such as dates and figs, are easily maintained.

Slaughter houses, dairies, butter and cheese, candy and various other manufactories now find it almost indispensable.

Cafés, hotels, bottling establishments, department stores, theatres and office buildings are incomplete without refrigeration plants of their own.

Steamships are enabled to carry perishable cargoes, provisions and supplies an indefinite length of time by its use.

ICE MAKING.

Owing to the uncertainty of the supply of natural ice and

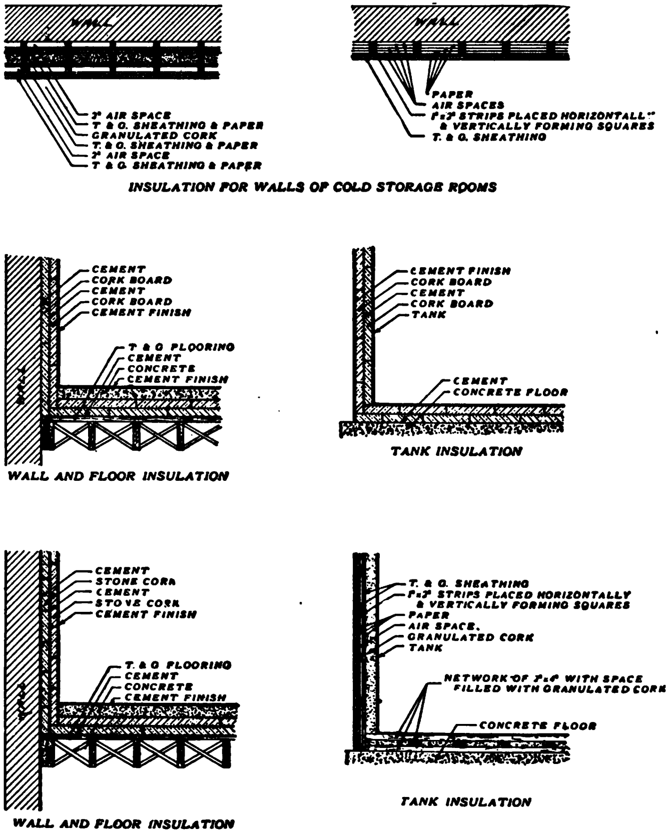


FIG. 4.—VARIOUS APPROVED METHODS OF INSULATION.

the difficulty met with in procuring it in the warmer climates, the manufacture of artificial ice has grown to be one of the most

important industries of modern times. This, of course, is due to artificial refrigeration entirely.

There are two common methods employed in the manufacture of ice, namely, the can and the plate systems, both of which have their advantages.

When distilled water is used, usually in the can system, manufactured ice is better than natural ice for domestic purposes, inasmuch as it is free from all impurities, which are removed during the distillation.

Many plants use exhaust steam from the engine room, which, of course, must undergo further cleansing processes to rid it of such foreign substances as it may have taken up in the boiler and engine. Most of this is removed in a separator. From the separator the steam passes through a condenser cooled by water from the ammonia condenser. The condensed steam is run through a skimmer which removes all remaining impurities. It is then reboiled, filtered, cooled and run into a water storage tank, wher the cooling continues until the water is almost at the point of congealing.

IN THE CAN SYSTEM.

the water is run into galvanized iron cans immersed in a tank filled with brine well agitated. The ammonia expansion coils are also immersed in the brine. As the ammonia expands the brine is cooled to a point well below the freezing point of water, generally 10° to 20° Fahr. After a certain length of time, usually two days, the water in the cans freezes solid, and the cans are removed. The outer surface of the can is heated by immersion in warm water or by sprinkling warm water on its sides and bottom. The ice is then easily removed and placed in the ice storage room.

THE PLATE SYSTEM OF ICE MAKING

differs from the can system in as much as the water if naturally pure does not need to be distilled. It is divided into two classes, namely, the dry plate and the wet plate systems.

Th tank in which the ice is to be made is divided into numerous sections by hollow or double steel plates placed 25 or 30 inches apart. In the dry plate system direct expansion coils are placed between the plates and the tank filled with water to be congealed. As the gas expands in the coils the water in contact with the plates freezes. After about a week the ice is ready to be removed. Hot gas is then turned into the coils, melting the surface of the ice adhering to the plate. The ice is then easily removed.

In the wet plate system brine is run into the hollow space between the plates, the expansion coils being immersed in the brine. The expanding gas cools the brine, which in turn freezes the water. When the ice is ready for removal the gas and

brine are withdrawn, and the space between the plates filled with water at ordinary temperature. When the surface of the ice is softened it is removed, as in the dry plate system.

Ice made by the plate system is said to last much longer than that made by the can system.

How to Read and Criticize Plans from an Insurance Standpoint.

By Charles C. Dominge, Insurance Engineer.

The time is rapidly approaching when the insurance expert will be called into consultation just as soon as the architect is engaged to draw the plans of a contemplated building. The "wise" architect (even today) sends for the insurance engineer realizing that it is better to have his ideas and suggestions before the structure is started, rather, than afterward when the "disgruntled" owner starts to kick regarding the exorbitant rate.

The writer from time to time has been asked to formulate a set of rules for fireproof buildings as a guide to architects, builders, mill owners, etc., and while each case should be taken care of individually the following will be of service:

1. All exterior windows on all sides should be protected with "approved" shutters, or, better still, "labeled" wired glass windows in hollow metal frames.

NOTE. The reason that wired glass windows are preferred is because they are more likely to be closed when the fire starts. They serve a double purpose by preventing an exposure fire, also by stopping a fire from leaping from floor to floor on the outside of building.

2. All interior floor openings throughout the building (i. e., stairs, elevators, chutes, dumbwaiters, light or vent shafts, pipe shafts, etc.) should be protected by 8 inch common brick shafts or 6 inch terra cotta or 6 inch concrete shafts with "labeled" fire doors at each opening. In the case of vent shafts, the openings may be protected with approved metal riveted louvres. The windows to the light court can be wired glass "labeled" Where the various pipes pierce the floors they should be stopped with incombustible material.

3. The skylights throughout should be wired glass in metal frames except the skylights which appear over the fireproof shafts in which case the glass should be thin (not over ¼ inch) and a standard wire screen should be erected over the glass. The

screen to be No. 12 gauge, one inch mesh, situated 6 inches above and extending 6 inches over the edges on metal stanchions.

NOTE. The reason that thin glass is required over the standard shafts is, should fire occur in the shaft it could speedily break the glass and leave the shaft (chimney fashion) while the screen above would prevent the flying embers (from the adjoining buildings) entering the shaft.

4. All structural steel or ironwork (including beams, girders, etc., piercing shafts) should be protected by at least 2 inches of Portland cement concrete or 2 inches of terra cotta. The lower flanges should be protected as above.

5. All floor surfaces should be of incombustible material, preferably cement, and where possible should be provided with scuppers or floor drains to carry off the surplus water.

6. The floor areas should not be over 5,000 sq. ft. In buildings of large area it is advisable to cut off sections with at least 12 inch common brick parapetted walls and place lock-jointed fire doors at the openings on each side of the wall.

7. The height should not exceed eight stories.

8. Wherever any hazardous work (such as enameling, dipping or japanning) is carried on recommend cutting off the enclosures in at least 12 inch common brick side walls, increase the ceiling and floor arches to 12 inches, properly vent the room to the outer air, and place an automatic "labeled" fire door at the opening.

9. The boilers should be placed under the sidewalk or in a one-story brick extension, cut off with a 12 inch brick wall and an automatic lock-jointed fire door at the opening.

10. If the building is to be protected with automatic sprinklers, you can ascertain the amount of water supplies necessary by the following method: Allow 100 gallons of water for each head. Take the number of heads each floor and divide by the number of stories to get the average number of heads each floor (say 150), multiply 150x100 = 15,000 gallons needed for the gravity tanks and one-half of the gravity supply, or 7,500 gallons of water for the pressure tank. This amount should be increased one-third for air. If all pressure tanks are desired you merely double the capacity of pressure tanks, which in this case would call for two pressure tanks, each holding 11,250 gallons (i. e., 7,500 water, 3,750 air).

Missionary Work by the Special.

Fireman's Fund Record.

The fire insurance agent in a town or city of 20,000 or less population should be the best posted man in town on protection

against fire, and as he has to depend on the special agent for information on that subject, a talk to him on fire department personal, equipment, water supply and policing, will be valuable to him and to his fellow citizens, and incidentally will benefit the Fireman's Fund.

Impress upon his mind that the promise of a new engine or a new water supply in the near future is not a good reason for an immediate reduction of rates.

The new fire department must be broken in, the new water supply tested, and, like all experiments, the breaking in is liable to be costly, but when properly harnessed and controllable under all conditions, reduced rates will follow.

The efficient bucket brigade fire department in the small town where fire buckets are kept filled and in place to be grabbed by the runner to the fire, who can splash a bucket of water straight, is often more effective in preventing conflagrations by stopping the fire in its incipiency than its successor, the "big engine," that has to wait for the engineer, at work at the sawmill, and for the chief who loses some time getting into his red shirt and putting his fire hat in place, that reaches the fire in time to save the lot and sometimes the adjacent property.

New fire departments sometimes create a restlessness among the active men that calls for exercise to show what the "masheen" will do; which restlessness causes a nervous active member, attaché or outsider to touch off a vacant building where nobody can be injured, particularly if it is insured. We have had many cases of this kind.

The water supply may be a pumping station some distance from the town, supplying a hose pressure of 100 feet or so in a test, but when a fire occurs and everybody is using the garden hose to wet down buildings, the pressure at the fire hose may dwindle down to 30 feet.

The pump may get out of order; the engineer may be out of order, and the fire may result in a total loss or general conflagration.

This class of water supply for a fire department, depending on a hose pressure only, should be reinforced by a reservoir for fire purposes only, at an elevation sufficient to give 100 feet pressure; but if fire engines are used it should be reinforced by cisterns.

The weak point in a small city fire department, in addition to lack of experience of the officers, is the political control which changes the officers and men with each administration.

The want of experience in dealing with fire on the part of the new men, or the part of the new chief and assistants, or

the old ones, who may hold over through all administrations, adds much to the high cost of fire insurance.

The department that throws water into the smoke and drowns the stock on the upper floors while the fire in the basement is supplying the smoke, or that sluices out the stock on the first floor while the waste basket, ten dollar fire in the rear office is furnishing the smoke (these are actual cases from adjusters' experiences), exhibits an inexperience that costs the people too much money.

Chiefs and assistants in the smaller cities should be drafted from cities of at least 500,000 population, where five to twenty alarms a day keeps the department in constant practice, and where a man can learn that when the fire is properly attacked, the smoke will be cared for without wasting tons of water on it.

The mayor, councilmen and other officers can consider or can take time to get legal advice on any new, to them, question that may arise; but the fire chief must decide from the appearance of the smoke, and decide quick on what he shall do; he has no time to get advice; he, like the captain of a ship in a squall, must give orders first and think afterward—in fact, his think-tank must be loaded up with experience in fires that will fit any emergency.

Proper policing cuts a big figure in fire prevention.

Policing does not always mean thief catching, hustling drunks, or preventing quarrels; it also means supervision; keeping backyards clean, preventing ventilating gratings from being filled with old paper, cleaning the rubbish, straw and other combustible materials out of basements, and many other fire preventing measures that an intelligent, open eyed, faithful watchman-policeman will have attended to, and thereby reduce the fire waste.

The reduction of the fire waste by the people will, through competition, be followed by lower rates.

THE INSPECTOR AND THE INSURED.

An Address Before the Insurance Society of New York Presenting a Helpful View of an Important Subject.

By F. M. Griswold, Chief Inspector, Home Insurance Company of New York.

I assume that in an assemblage of this character is to be found those whose presence is indicative of a desire to profit by the teachings which may come to them through the lectures and addresses which are provided by the Society for their consideration and edification, whereby the information thus to be gained may serve to more fully fit its membership for that measure of success in their profession which should be the reward of earnest effort in the accumulation of knowledge affecting a chosen line of activity.

In attempting to impart to you my conception of the importance of the subject under consideration, I fear that within the time allotted it may not be possible to consider other than the leading points concerning a matter which includes so wide a field of essential knowledge relative to the varied and intimately mutual interests which exist between the insured and the insurer, the proper harmonizing of which so often falls to the lot of the competent inspector, whose measure of success and whose value to his employer, as also to the insured, largely depends upon a proper appreciation of the importance of these interlacing relations, the knowledge of which will enable him to accomplish best results with the least friction in his intercourse with that aggregation of "the many men of many minds" which makes up the body of the insuring public, to whom in some instances the inspector may appear as an unwelcome critic, if not as an intruder.

In considering the duties of an inspector as related to his contact with the insured, let me give you an outline of my conception of the necessary mental equipment to fit him for success in that line of endeavor: Primarily it may be conceded that the man who has had a technical education holds an advantage which should enable him to more rapidly advance in comprehension and accomplishment than usually falls to the lot of one not so endowed, but experience has demonstrated that such foundation is not absolutely essential, as some have succeeded without it; however, when technical knowledge and scientific attainments are secured through the process of abrasion and attrition in the

hard school of experience, the graduate has paid dearly for his lack of earlier training.

Whatever the method of technical accomplishment—whether it be founded on training in a technical school or be the result of later effort, the aspirant for success as an insurance inspector should be somewhat familiar with insurance practice and be endowed with a broad complement of common sense; have an inquisitive and observant mind coupled with a desire to investigate the "why and how" of every problem; a constantly receptive brain, a retentive memory, an insatiable thirst for knowledge, and be possessed of that higher faculty which will enable him to be an imparter of knowledge, a teacher of those less thoughtful or less informed, and finally, to be imbued with such resourceful ingenuity and capacity as will fit him to plan and carry out the details of technical propositions to a successful issue.

Assuming that the inspector is "charged with knowledge" as well as with the other attributes indicated, it seems well to discover what is meant to be included in the interpretation of the word "inspect." The dictionary defines it to be "a critical examination; close or careful survey or investigation of something of special moment; to ascertain by examination the quality of work"; hence, an inspector is "one whose duty it is to secure by supervision proper performance of work, in order to make a formal report."

Elaborating these definitions for application to the duties of the insurance inspector, let us broaden the word "work" to include in its meaning "condition," in the sense that the latter word represents the result of work performed, including the method and process which produces the condition creating and controlling the hazards to be investigated. Then, in order to comply with this broader interpretation of the definition, the formal report to be made by the inspector must be based upon the facts developed after a critical survey and examination of the nature and condition of all matters subject to his investigation.

Assuming for the purpose of illustration that the subject of inspection is that of a manufacturing plant or special hazard, it will then become necessary to closely scrutinize all matters which in any manner serve to create or to promote the fire hazard, including the character and nature of the raw stock or material to be used, following it through all processes of its manipulation, from its reception at the plant, its handling and storage, to the completion of the operations necessary to produce the finished goods or article, and to carefully note and define the hazards incident to each stage of progress where physical or other changes affecting the conditions may take place, and in addition to these purely technical investigations and conclusions, to closely ob-

serve and study "shop practice" or management, including supervision and discipline of employees, as related to cleanliness and care of hazards which form the basis of "good housekeeping," which is one of the most important essentials in securing safety from fire in all classes of property.

The nature, means and method of fire prevention practices should be carefully investigated; the apparatus and appliances for fire protection or fire defence should be very critically examined and described; and when the assent and co-operation of the insured can be secured, tests for efficiency of such devices should be undertaken, but the inspector is cautioned not to make such tests on his own initiative without permission and co-operation. The nature and conditions of the structures forming the plant or risk require careful consideration and full description, and finally, the information gained should be embodied in a written report of such lucidity as to convey a mental photograph of the hazards and conditions to the minds of those who have to decide upon the acceptability of the risk from an underwriting viewpoint.

I doubt not that to some of those present even this much abridged summary of the

PRIMARY DUTIES OF THE INSPECTOR

will appear arduous and difficult of accomplishment, because of the breadth of technical and general knowledge necessarily to be attained in order to comprehend even the salient points of the applied sciences which serve to create, promote or control the hazards of fire incident to business practices in this age of progress, which gives to us each day some new and unknown problem of our study and solution as to its fire or life hazard.

However, none who aspires to success need be discouraged through contemplation of these seeming difficulties, for it should be remembered that all of the teachings of the past serve to admonish us that the fruition of hope for advancement in knowledge or estate is the result of difficulties overcome and obstacles surmounted, and that the road to success still remains open and free to him who persistently strives to reach the goal, and he should therefore be encouraged to persevere, for, when fully qualified, the inspector stands on a high plane of usefulness as a conservator of public welfare in matters affecting the hazards of life and property, through his fitness to act both as mentor and guide to those who have not included the science of fire prevention and protection as an essential in mental and business training.

Holding this conviction as to the high station of the competent inspector, let us consider what should be his attitude in relation to his contact with the insured in matters connected with his inspection work. Primarily, the inspector should fully realize the fact that "every man's house is his castle," and there-

fore may not be invaded save at the pleasure of its owner; the mere fact that an insurance company has assumed a contingent liability on the property in the form of an insurance policy, and therefore has a business interest in the risk, does not carry with it any right of entry save at the courtesy of its owner; and when such entry is gained, an investigation of conditions becomes a matter of sufferance, which may be rescinded at the pleasure or caprice of the owner.

Therefore, when an inspector is called upon to enter a plant for the purpose of inspection, he should first seek an audience with the owner or manager, to whom he should exhibit such credentials as will prove him to be authorized by his employer to make such inspection, and in a gentlemanly manner ask the privilege to make the investigation, carefully avoiding even the appearance of demanding an entry as a right, to the end that this preliminary of introduction may place the applicant for favor and the insured, who is to grant it, on mutual grounds of amicable courtesy.

HAVING GAINED PERMISSION

to make inspection, it is always wise to briefly outline to the proprietor the purpose of the visit, and to give assurance that there is no intention to unduly pry into matters which do not affect the hazard, letting it be known that where such hazards are existent in the knowledge of the insured, but not readily discoverable through inspection, the mutual interests of both parties to the contract are best served when each strives to be frank with the other in such matters.

Approaching the insured in this manner usually results in securing his confidence on the start, and this condition may be materially reinforced by personally discussing with the insured conditions discovered which tend to create or to promote the fire hazard, not neglecting to express satisfaction where the management of the plant is to be commended, as a few words of deserved compliment go far to mollify antagonism engendered through criticism, for in some instances the insured may be found disinclined to admit the existence of defects cited by the inspector, basing his doubt upon his assumed knowledge of the conditions of his plant, and in such cases the position of the inspector is materially strengthened by his ability to point out the defect in place, and in the presence of the insured to make plain the reasons for suggesting the proposed betterments, which should be founded on "both the law and gospels" of accepted practice.

With this thought in mind, I desire to caution the inspector against trusting to his memory as to conditions which need to be corrected, and to suggest that a special note be made in each case, indicating the nature of the defect and the locality in which

it was discovered, rendering such items prominent by underscoring them with red or blue pencil, and using such points as his "texts" when in conference with the insured after an inspection, when, being sure of his ground, the inspector should have the courage of his convictions and clean up all criticisms while on the premises and in the presence of the insured. Do not run away from an inspection and write to the insured in relation to matters which ought to be disposed of during your presence at the plant.

THE PRACTICE OF "CLEANING UP"

as you go will be found of particular value when, as is sometimes the case, the insured thinks he has a secret process, an unpatented machine or method in production in relation to which he is disinclined to permit investigation by an outsider, for in such instances the inspector is confronted with conditions demanding the exercise of consummate tact and diplomacy to overcome the suspicions of the insured that under the cloak of inspection he may be harboring a spy from one of his rivals in trade, but as no two of such cases will be found so alike as to permit the making of a fast and hard rule of approach, the wit of the inspector must prove his guide in each case, but he should exercise a large measure of patience in attempting to overcome the objections offered by the insured, to whom it should be made plain that in order to make a report of value in the case, the inspector must personally observe and understand the hazards which may be incident to the hidden processes, and while willing to *believe* as truthful explanations made by the insured, it is impossible to *know* the conditions without personal investigation, and in order to fortify this position, the inspector should obligate himself not to divulge the information sought, and if then permitted to investigate, he is in duty bound to hold as absolutely inviolate the confidence thus reposed in him by the insured.

IN CASE OF AN ABSOLUTE DENIAL

of opportunity to look into the hazard of any supposed trade secret, the inspector must, perforce, choose between two courses of action in order to make an intelligible report—the easiest and at the same time the most unsatisfactory decision would be to attempt reaching a conclusion as to the gravity of the unknown hazard by analogy predicated upon the nature of the processes and methods already developed by investigation of the risk under view, or from knowledge gained in like plants; but the safe and wiser course is to take the benefit of the doubt and get off the risk, when both argument and appeal fail to convince the insured that it is unwise to face a contingent liability depending upon unknown conditions; in other and more homely words, "never buy a pig in a poke."

Another problem which is difficult of solution to the satisfaction of either the skilled inspector or the insured is the necessity for the correction of improper conditions brought about by the insistence of the tyro in inspection work; such, for instance, as forcing the placing of fire doors on each side of a brick basement division wall when the floors and superstructure above the wall were entirely of wood; insistence upon the hanging of a fire door at an opening between a brick factory building and its shed-roofed boiler house, while leaving the windows immediately above the combustible roof entirely unprotected. These two cases are cited from my personal experience, but many other illy advised conditions might be mentioned, some of which doubtless would be familiar to the experienced inspector.

In cases of this character the insured is more or less justified in claiming that if forced to make changes and improvements in accord with the whim of every so-called inspector visiting his plant, his day of trouble will never end, but if the inspector is properly equipped with knowledge and diplomacy, he will be able not only to suggest the proper remedy, but be skilled enough to demonstrate the correct method of procedure to secure the desired results. A friendly discussion of such matters with the insured often brings satisfaction all around; even if the impression made does not result in immediate action for betterment, it is "seed well planted" and will bear its fruit in the future.

Reflecting upon what has just been said in relation to the difficulty of correcting errors in practice, due to the ignorance or self-sufficiency of the inexperienced inspector, I am led to caution you against that false pride which prevents the open acknowledgment of ignorance in relation to anything coming under observation, and cite for your encouragement that trite aphorism which admonishes us that "the realization of ignorance is the foundation of wisdom"; hence, as it is not given to any man to *know* everything, the wise inspector, when confronted with new and novel conditions, will evidence his wisdom by admitting his ignorance, and gain knowledge by asking questions and seeking explanations as to processes, causes and effects which may be new to him.

In my experience I have found a

CONFESSION OF IGNORANCE

of almost inestimable value under such conditions, and have learned such by throwing myself upon the generosity of the insured for enlightenment, finding them in almost every instance both willing and competent instructors when properly approached.

Unless the inspector is skilled enough to comprehend all of the hazards incident to the risk to be inspected without assistance from those familiar with the plant, he should seek to be accom-

panied by the proprietor, manager or other person in authority during his tour of inspection, in order to be enabled to point out defects as developed and to secure information as to hazards and conditions, the nature of which is not self-evident; when so accompanied, the inspector should realize that the absence of his guide from regular duties must entail expense upon the insured, but at the same time should not permit himself to be unduly hurried in his work, as the value of the "formal report" to be made depends upon the fullest comprehension of the matters investigated; take time enough to make the fullest notes of all conditions affecting the risk and influencing your conclusions at the time such matters come under your observation.

While there has here been given you the merest outline on some of the more important features which should be considered under a proper treatment of this important subject, let me in closing again impress upon you the fact that the inspector, because of his calling has no inherent right or authority to enter a plant for the purpose of inspection except by permission from its owner, nor has he power to enforce compliance in matters calling for changes, improvements or betterments, and should therefore confine his criticisms to such features as materially affect the hazards, and the amendment of which are essential to approval of the risk.

ALL NECESSARY CRITICISMS

should be carefully considered by the inspector before submitting them to the insured, and should be presented in the nature of "suggestions" based upon accepted good practice, and in such manner as to convince the insured that compliance therewith will serve his best interests in the prevention or control of fire, making the argument "an appeal to reason." When the conditions criticised are such as to seriously jeopardize the safety of the plant, and immediate compliance with the suggestions cannot be secured, the only recourse is to get off from the risk, and the insured should be so advised, for while he is privileged to "take the chances" in such cases, the insurance company is not obligated to do so, and it is an evidence of sound underwriting to avoid any risk when it becomes necessary to threaten cancellation in order to secure promise of reform by the insured.

While the majority of men resent a demand to do anything which appears to reflect upon their method of business practice, almost every man will welcome friendly suggestions in criticism when so presented as to carry conviction of their feasibility and value in relation to the betterment of his own plant, and through this method the skilled inspector will many times succeed in securing needed reforms, even if he represent only a single company holding liability.

ARTIFICIAL FLOWERS AND FEATHERS.

Processes of Manufacture of These Millinery Trimmings Described—Hazards Pointed Out—Susceptibility of Stock to Damage.

By Walter O. Lincoln, Inspector, New York City.

When the belles of Fifth Avenue have their hats trimmed for the Easter parade, they give no thought to the poor girls who have labored for months to supply the Easter demand for "trimmin's."

The art of flower making in this country has been copied from the French and German. There has been little change in the method of manufacturing in several years.

It is one of the few trades for women which has not been revolutionized by machinery and should attract women of artistic taste. The length of season is from three to eight months, the busiest time being September and October; January and February depending upon the "will and fashion of women."

There are two distinct types of shop—either the large loft or a floor in a converted dwelling in a run-down section of the lower West Side of Manhattan. One-third of the shops are in the latter class, which seem unsatisfactory for the purpose intended. One-half of the industry is carried on in tenements by home-workers, who receive from twenty to twentyfive cents a gross for assembling flower sprays, consisting of stem, bud, pep and leaves. About four gross can be made in a day. The shops pay from six to fifteen dollars per week, according to expertness and demand for help and the quality of goods made.

LEAVES.

Plain green leaves are by far the simplest thing made in the trade. Usually it is a separate business, though many firms combine this with other products. They are made of muslin, sized with gum arabic and glycerine. The more expensive ones are sized with castor oil, olive oil, gelatine and paraffine, which softens the texture, after which they are varnished or shellaced by hand or machine. Acetone, amyl acetate, turpentine or benzine is used for thinner. The sheet muslin is cut into squares of about four feet; tacked to a four-sided wooden frame; painted with aniline green, thinned with water or alcohol; dried and removed from the frame. The muslin is placed on several thicknesses of newspaper on a heavy sheet of lead, and the leaves cut out by hand. The operator strikes the die with an iron raw-hide covered mallet, weighing six to twelve pounds. As many as

two dozen leaves are cut out with one blow. The newspapers and lead prevent the edges of the die from turning. The stems of chenille wire are then pasted on with fish glue or cold flour paste.

The ribs and veins are formed by pressing the leaves in hollow dies, lined with paper or felt to prevent the impression of the stems showing on the opposite side. The press is similar to an ordinary letter copying press, with screw and wheel. The dies are of two kinds: either stationary and heated by gas burner or a wooden handled portable die is used on a portable iron plate, which is heated and placed under the screw. The presses now used are all iron and far superior to the wooden bases formerly used. It is claimed on good authority that the gas heated presses are injurious to the health of the operators, who are required to sit many hours with the lower limbs extended under the press with gas burner near by, which overheats the abdomen and causes stomach trouble. Many of the more humane manufacturers use the portable die with heated plate. This serves the purpose, as only sufficient heat is required to warm the die.

The autumnal colorings are produced by various means. Before the muslin is removed from the frame it is irregularly slashed with a darker hue of varnish, which gives the finished leaves the peculiar dark markings of the autumn beech or maple leaf. An air brush with aniline colors and a drop of gall added for setting is also used.

The poinsetta, so much in vogue during the Christmas season, is usually made of velvet faced muslin. The velvet is pasted on the muslin and both cut out at one time. They are always red; but other velvet faced flowers are tinted and shaded as above described. Excess coloring is removed with benzine and shading is done with a rubber stamp.

Holly leaves, made of soft, heavy paper, are dipped or painted with liquid bronze, thinned with banana liquid.

Paraffine coating (called "waxing") is used as a preservative on flowers and leaves.

Tinsel, made of ground glass and mica (imported from Germany) is sprinkled on leaves and Christmas greens to represent "frosting" or "snow."

Leaves are dipped in "fecule" (French for mixture of corn starch and potato flour) to produce the soft face of the chrysanthemum and for "dew."

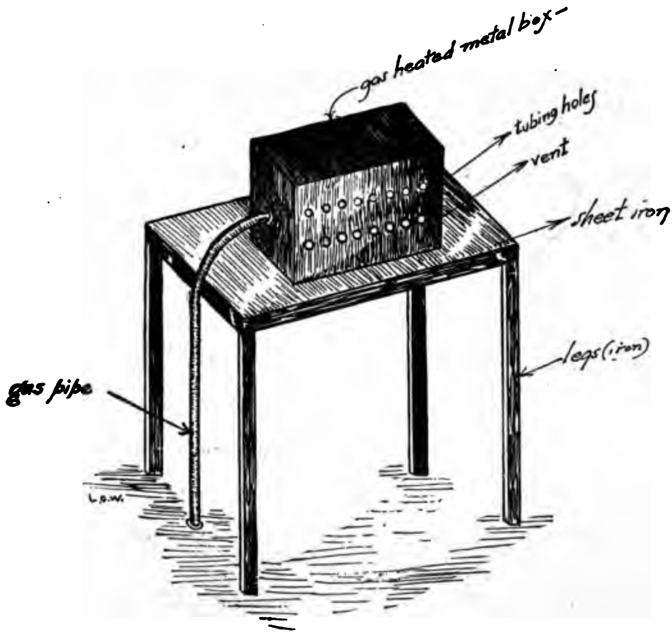
Celluloid is very seldom used for leaves.

TUBING

is the hollow muslin stems. The muslin is sized with warm boiled oil passed through a wringer, cut into strips one-fourth to one-half inch wide, wound on a wooden frame and drawn through the "tubing" machine to a wooden reel. This machine

is of iron frame, the number of burners governing the size. For a single burner, the base will be about 8 x 30 inches, set on 3-foot iron legs. On the center of the base is a metal box with gas burners beneath. On each of the long sides of the box are two rows of holes, one above the other. The top one, through which the muslin passes, is smaller than the lower vent hole. The strips would not retain the curl if not heated—hence the gas burners.

Some firms use a dyeing machine. This is simply a tank of cold aniline and water stain with wringer and drying frame.



Tubing Machine

DRYING.

Leaves and tubing are dried on the frames before being cut. It is exceptional to find an approved drying apparatus. Large

factories may have an entire floor for drying purposes heated by coal stoves. The smaller firms invariably use coal stoves, around which are placed the frames with, or without, wire guards or screens. Wood or metal gas-heated dry boxes are familiar.

FLOCK TUBING

is the name given ordinary tubing after being coated in warm boiled linseed oil or varnish and covered with hair or wool flock while wet. The strips while on the wooden frame are set in wooden tumblers operated by hand and are covered while the tumbler is in operation. This produces the downy, hairy stem (called "tomentose" by botanists) of the moss rose, begonia and some species of geranium.

CIROLEUM TUBING.

"Ciroleum" is French for wax and oil. The mixture is glycerine and gelatine, to which is added small seeds. It is the dark flexible tubing resembling rubber and used on the better grades of foliage. The mixture is heated by gas or steam, poured into a small metal tank located on top of a wooden frame surrounding a wire arrangement (see sketch) resembling a squirrel cage set on end. The ciroleum falls by gravity through small holes in a thick, paste-like liquid, and as it falls covers heavy steel wires in an upright position on the revolving wheel. The cage is turned until all the wires are covered. The wires are coated with talcum to prevent sticking. One firm covers ordinary tubing with ciroleum for a stiffer material.

Tubing for wreaths is "cross-hatched" between two rows of nails driven a few inches apart on a flat board, tied and cut at regular intervals between alternate nails.

FLOWERS.

Nearly all our natural flowers are reproduced by flower makers. As they are legion, only a few of each type will be mentioned, the process of manufacture being the same.

The most popular flower is the rose. The pollen stem, calyx, and petals are made separately. Silk is mostly used for rose petals and pansies, although a great many are made of velvet, woven gold thread and brocaded cloth. The petals are cut the same as leaves. In some shops a power press uses twelve dies at one operation.

The variegated colors are made by one of the following processes: Stencils (a different one for each color), air brush, hand brush or medicine dropper. Aniline colors are used. The excess color is blotted by hand. If the petals are a solid color, a press resembling a wine press, with an open side and trough beneath to catch the drippings, is employed.

"Goffering" and "crimping" follow. A "goffer" is a gas-heated

tool with a ball end and short wooden handle. The petal is placed over a round hole in a piece of wood, into which it is pressed by a warm goffering iron, the result being a curled rose petal. The ends are creased, called "gripping" or "pinching," in a small gas-heated crimper, operated by hand.

Rosebuds are made of small oblong pieces of silk, silk ribbon, chenille of various fancy kinds and raffia. These are assembled by experts. A wide table is used, on which is placed small piles of the necessary materials in front of each of the workers. The flower is made up in the following manner: The pep (flower center) or a rose bud, of the proper color and variety, is selected. Around this center the petals and calyx are arranged, then wired. The wire stem is wrapped in rubberized paper. There is no hazard attending the process of assembling.

VIOLETS, CARNATIONS AND CHRYSANTHEMUMS

are made of paper, stamped out the same as leaves. The chrysanthemum leaves are curled by hand with cold irons. The petals are bunched on wires and assembled with muslin leaves and bound with chenille. The violets and carnations are dipped in wax. The hazard here is the method of heating the paraffine. After dipping, the flower is shaken to remove the excess wax, and the wood-work surrounding becomes coated with the spattered wax. Some firms leave the walls bare, some use metal, and some asbestos paper on the walls.

PORCELAIN FLOWERS,

used for permanent decorations, as for cemetery plots, are imported from Germany. The cost of a complete rose, about 5½ cents including tariff, precludes competition in this country. The foreign workers receive about two dollars per week.

Metal flowers for cemetery wreaths are stamped out of tin, painted and soldered to wire frames. This involves a tinsmith shop hazard with painting. The paint in dip tank is usually thinned with benzine.

"PEPS."

Pollen stems, flower centers and small berries are called "peps." Some are machine made and some hand made. The machine is automatic in operation. It is a long iron frame, operated by endless chain. Heavy thread is spooled on a reel at one end, drawn first through a sizing pan, dried by radiated heat while passing over sheet metal with gas burners below, clamped at short intervals, cut in lengths of from two to four inches, dipped in pollen paste, then in a dry powder, and delivered at the opposite end of the machine in long rows of "peps" clamped to iron strips. These are removed and finished by hand. The dip size is made of starch and gum arabic; the paste, earth colors with gelatine

body; colors, aniline; flour, potato and starch. The hazard of this machine is the heating arrangement, usually small portable gas burners with rubber tube connections under the frame and size kettle.

The French hand-made peps are made of the same material, being clamped to a four-sided wooden frame (called "spanning"), cut into lengths of two to four inches and dipped into paste. The German method is to paste the threads to the frame to more securely hold them in place. The threads are always dipped in gum arabic and starch sizing. The dip pans for peps are small, narrow and gas heated. One dip into this thick paste is sufficient for pollen stems, but for holly berries, etc., the dipping into paste and into starch is repeated until the required size is obtained. Paint or varnish coating is then applied and the peps dried.

BERRIES, CHERRIES, GRAPES AND FRUIT

are made same as peps. Before blackberries are varnished they are coated with gelatine and coriander seeds for the natural berry effect. Strawberries are dipped in hominy for the seedy outside appearance. Cherries are made mostly of cotton centers. These are wet and placed in moulds of a treadle machine, which in revolving rounds out the cotton on a wire or wooden stem. They are colored the same as berries. Grapes are also made of glass, varnished and painted, or (for plums) are covered with velvet, the stem near the fruit being first covered with cotton. The more expensive grapes are of gelatine and imported. Fruits, such as apples, pears and peaches, are moulded the same as cherries. They are dipped in a base color, tinted with air brush and dried.

Lily stems are made of chenille and cotton, rolled to form the stem, dipped in pollen paste and covered with farina.

Wool is used for daisy and sunflower centers.

Spagman moss from the New Jersey meadows is used for flower "beds."

Aigrettes (imitation) are of horse-hair, sewn to narrow strips of cloth and wound on wires. Grass, cut into narrow strips and colored, is used for aigrette sprays.

Sheaves are made of Italian wheat straw. It is claimed that Italian wheat is the only straw that can be used, the Italian sun and climate being necessary to produce the proper grade for durability. Water and aniline stain only is used.

Raffia is used extensively for grass, baskets and theatrical decorations.

PRESERVING AND FIREPROOFING

material, for both natural and artificial foliage, contains sulphate of ammonia, silicate of soda, rock salt, sugar, glucose, and

chlorine. The process does not render them incombustible, but slow burning at ordinary temperature. They curl and discolor upon the application of direct flame. Sugar is used in the solution for the lighter shades; glucose for the darker shades and for a glossy surface. Materials are mixed in open wooden tanks. Chlorine is used only for the hardy plants, such as evergreens, palms and trees. It is necessary to first coat asparagus, heather and Italian boxwood in a gelatine or paraffine bath after staining to retain the color and prevent breaking, as they are rather tender. Palms are first fireproofed, stained, ironed and then painted. Bleaching of natural plants is done with sulphuric, hydrofluoric and acetic acids in thin solutions. Acetic is used for delicate plants, such as asparagus, Italian sagus and immortelles.

FLORISTS.

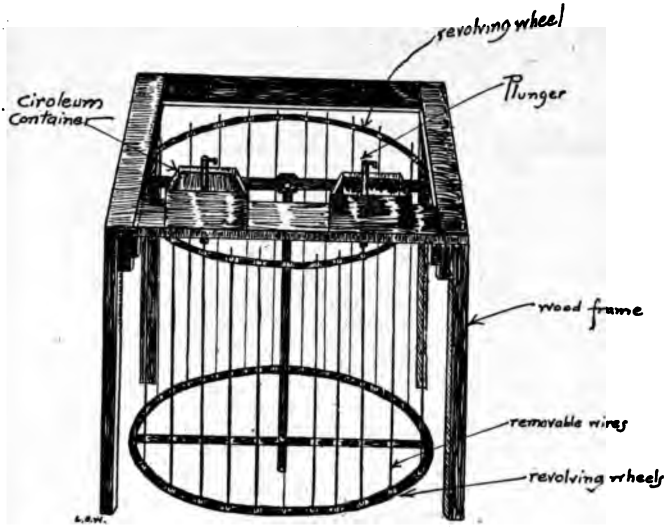
Aside from the natural flowers which are kept in ice boxes, the florist is called upon to make floral designs and set pieces. The moss used for beds is received in bales, moistened, bound to a metal frame, covered with tinfoil, and the flowers stuck in. They also carry a line of waxed flowers. Florists near cemeteries have stocks of all metal wreaths, porcelain flowers, etc. They are paid to keep cemetery plots decorated for certain periods. At the end of the period the moss beds and wire frames are returned to the shop. This necessitates remaking the beds and repainting the frames.

FLORISTS' SUPPLY HOUSES.

A glance into one of these shops will remind one of a decorated summer garden prepared for a lawn fête. On all sides and hanging from the ceiling are displayed baskets of raffia, rattan or reed, filled with natural and artificial palms, ferns, grasses and flowers. The stocks are usually crowded and the aisles narrow. Glass vases, rustic furniture, bark and leaves form part of the stock. Excelsior is used for packing.

STOCKS.

As in all lines of manufacturing, there are firms who job in the several kinds of materials employed by the trade. Thus we have flower makers' supply houses, which have sheet muslin ready sized for leaf makers, various kinds of tubing, some a general line, including rubberized paper, moss, chenille, powders, peps, and dies for standard patterns. They are kept in wooden bins, tills, or pasteboard boxes. The finished product of the shops is found at the wholesale dealers. These dealers are of two classes, either the large Broadway merchants with large floor areas or the small dealer found on the side streets. Perhaps one-half of the larger firms' stocks will be imported. Few of them do any manufacturing of any account.



Ciroleum
Tubing Machine

REED AND RATTAN BASKETS
are worked the same as in wicker baby carriage factories. The material is water soaked to make it pliable, woven and stained or painted. A gas-heated dip tank with aniline dye and glycerine is used. Making wood or bark baskets is a separate trade involving a wood-working hazard with painting and varnishing.

Wire frame making requires a tinsmith shop with soldering, bending, drilling and cutting. They are dipped in a tank of benzine-thinned paint. Enamelling, bronzing and lacquering is done by air brush; varnishing by hand. Sometimes celluloid enamel is used. These liquids are thinned with amyl acetate, benzine or turpentine. Open lights should never be near the air brushes or dip tanks and rooms should be well ventilated.

FEATHERS.

"Manufacturing" of feathers appears to be a misnomer, the work being that of a renovator or converter of the raw material into the finished product without changing the character of the material.

Ostrich feathers are mostly used. Chicken feathers are used for quills, herons for wings, while birds of paradise and aigrettes were formerly imported. Dealers in raw ostrich feathers keep their stock in bins according to quality. Manufacturers and dyers first sort them, then wash them and whip them over a board to open up the flues, dye and redry. The imperfect ones are shortened for "tips," trimmed and bunched. Wire or rubber cement is used as a binder. This is called "branching." At long tables are seated rows of girls, each having a bunch of feathers and an open dish of rubber cement. Over the tables is a row of lights, usually gas. Plumes receive better attention and a more expert class of help is employed. When dyed, they are dried, steamed to open up the flues, wrapped in cloth to retain the moisture and hand curled with cold irons. The coloring used is aniline thinned with water or alcohol. An open set iron boiler and a goodly supply of rubber cement used from open dishes are hazardous features of these shops. Feathers are placed in a gas-heated crimper, which binds the flues and gives the "pompon" effect. The ends or tips are colored with air brush. "Paring" or reducing the thickness of the stems is accomplished by running the feather between an emery wheel and iron roller operated by power. Drying is done in a metal gas-heated dry box, or in a drum with wire mesh sides, or in an oscillating metal pan heated by gas. Corn starch used after drying fluffs up the flues.

ARTIFICIAL WILLOW PLUMES

are made of ramie. Ramie is a shrubby Chinese or East Indian perennial of the nettle family with numerous rod-like stems four to six feet high and large heart-shaped leaves, silvery white beneath; cultivated in West Indies and United States. The fine fiber yielded by the stem of this plant is now coming into use for almost every purpose heretofore served by cotton. It is very strong and durable. Imitation willow plumes, napery, braids and trimmings are being made of ramie. In appearance it is similar to thrown silk and woven similar to straw braid in straw hat factories. For plumes, the ramie is sewed on a knitting frame in two breadths with a stiff binder in the center for the stem and a similar binder on each end. When the proper plume length is reached, it is removed and the outer binders cut off. Steaming, curling and tinting are done the same as with natural feathers.

HOUSEKEEPING.

Good housekeeping is essential. Small pieces of newspaper around stamping blocks where leaves are cut out and pieces of muslin in rooms where tubing is made accumulate very rapidly and should be removed daily.

SUSCEPTIBILITY.

Stocks of artificial flowers are more susceptible than millinery and few companies write them. Appreciation of susceptibility to water damage is shown in a shower by the ladies whose hats are trimmed with flowers, and evidenced by their covering the flowers with their escorts' handkerchiefs or by tucking their hats under their wraps. Even a small fire where any quantity of water is used, or where much smoke is emitted, will cause large losses and but little salvage can be expected. The imported rubberized paper which is used instead of tissue paper is susceptible to changes in temperature, and especially to heat. When kept in large quantities they should be stored in a cool place.

When fashions change from wearing flowers to the wearing of feathers, the flower shops are converted into feather shops. When ribbons and laces are in vogue, a severe moral hazard presents itself in the closing down of both kinds of shops. In all trades which are arbitrarily governed by slight changes in fashion, short working seasons are the rule and a large capital is essential to tide over the firm during the dull season. Changes in fashion relegate uncalled-for patterns to the storage closet. These patterns are hand-made and the more expensive are imported. The inside of the dies are lined with paper to exclude moisture. They are made of tested steel and are susceptible to water damage. Tool making is a separate industry.

PROFESSIONAL DECORATORS

who make a business of decorating ballrooms, restaurants and palatial private dwellings for special occasions necessarily keep on hand large quantities of supplies. Where special orders require, goods must be made. For this reason they have facilities for making the various kinds of decorations, and while the underwriter may look for only a stock, there is usually present a full-fledged flower-maker's shop. In the manufacturing of leaves, the storage and use of acetone, amyl acetate, turpentine, alcohol, benzine and liquid bronze is an important feature. The supply should be small, stored outside, and used as far as possible from safety cans. No open lights or frames should be permitted in rooms containing these liquids.

The former wooden base die presses with gas heat caused numerous fires. This hazard has been minimized by the use of iron presses.

DRYING

is one of the most serious hazards. Where entire floor areas are used for drying, as in the old-time factory, the gas jets between the rows of frames should have substantial metal guards and the coal stoves should be watched very carefully. Where

a large dry room is not necessary an approved all-metal drying box set on legs six inches above the floor and vented to the outside should be used. As the frames for tubing and leaf muslin are quite large, a dry room is necessary. The partitions of this room should be of 4-inch terra cotta blocks, brick or concrete or double ⅞-inch boards laid crosswise and lined with lock-jointed tin. Steam heat is preferable. The coils should be free from woodwork and (where live steam is used) screens should be used to prevent materials from falling on them. Invariably an ordinary pot stove is used, the frames being piled around and over the stove, which has resulted in many large losses.

CELLULOID.

Where celluloid is used, it should be kept in heavy sheet-metal boxes as per requirements and only a day's supply kept on hand. Foot-power presses for cutting are less dangerous than power presses, owing to lack of high speed and consequent friction. All scraps should be kept in metal safety waste cans.

Gas is used for crimpers, grippers, goffers and tubing machines. If the connections are of iron, little actual hazard exists, except by leaving the gas turned on when not in use. Direct heat is employed for warming linseed oil for coating tubing muslin in preparation for the flat covering. The oil pan should have flanged sides to prevent the oil from dripping onto the burners. This applies also to the ciroleum mixers.

The making of metal flowers involves the ordinary hazard of a tinsmith shop with soldering and painting. The dip tank containing-benzine-thinned paint is a serious hazard. This method of painting should be done outside of the main building.

There is little hazard in the preserving and fireproofing process. Steam is employed for heat. Natural air drying is the usual method. Frequently large quantities of unfireproofed foliage is stored in yards and sheds. As they accumulate and dry out, they become a menace to a factory and make fine fuel for flying sparks or a carelessly dropped match.

"Waxing" has caused many fires due to the method of heating. Direct coal or gas heat should not be used unless the wax pot has flanged sides. Where steam is not obtainable, the gas pot should set in a water jacket when coal or gas is used and the surrounding woodwork covered with metal or asbestos.

The fine spray from the air brushes impregnates the air and if confined in a room with open lights or flames will cause an explosion. The Board of Health now requires that rooms in which air brushes are used shall be partitioned off from the balance of the floor and fans used to carry the vapor to the outside of the building.

In florists' supply houses large quantities of packing materials, such as straw and excelsior, will be found. A standard, lock-jointed, tin-lined bin is recommended.

Pep making utilizes many materials and some hazardous liquids as described. Where made on a large scale, the different species of goods are made on separate floors, where will be found numerous gas-heated dipping tanks, dry boxes and air brushes.

In basket making, the most serious feature is the staining, dip painting and enameling.

In feather shops, the dyeing hazard with an open set iron boiler and poorly arranged drying rooms are familiar features. For the convenience of "branchers," the rubber cement is used from open dishes. Gas lights should not be used over the tables. The supply should be kept outside in the benzine house. The same kind of safety pots as are used in shoe factories can be used in branching without loss of time or inconvenience to the workers.

THE MANUFACTURE OF ILLUMINATING GAS.*

Description of the Processes of Gas Manufacture, with Diagrams of Model Plants—Fire Hazards Pointed Out.

By Stephen Lawrence Burgher, Inspector, Underwriters' Bureau of New England.

Illuminating gases as manufactured in the United States are principally of two varieties, known as water gas and coal gas. Based on the latest available figures of the United States Geological Survey, the total gas sold in this country per year is as follows:

	Cubic feet.
Natural gas	140,584,000,000
Manufactured gas	157,211,000,000
Total	297,795,000,000

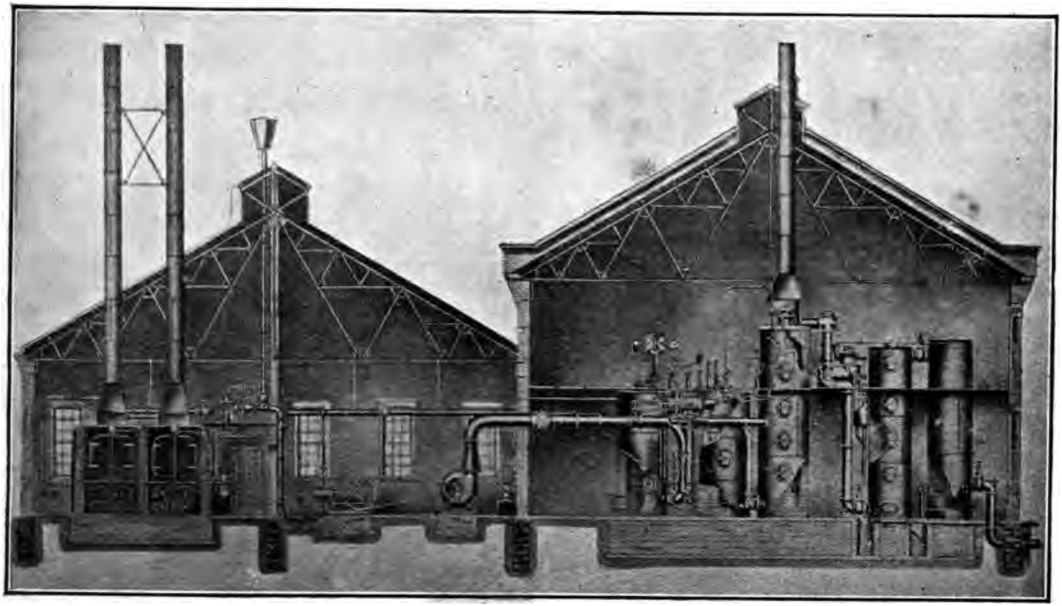
The manufactured gas is divided as follows:

	Cubic feet.
Coal gas	45,000,000,000
By-product coke oven gas	9,000,000,000
Water gas	103,000,000,000
Acetylene gas	23,000,000
Gasolene gas	188,000,000
Total	157,211,000,000

Leaving out of consideration the acetylene and gasolene gases, the latter covering the numerous methods of diluting light oil vapors with air, it is apparent that approximately two-thirds of the manufactured gas sold in the United States is water gas. Approximately the other third is coal gas, and as these two gases form such a large part of the manufactured product, the others will not be considered in this article.

Statistics on the manufacture of gas taken from the thirteenth census of the United States in 1910 show that there were 1,296 establishments, having an invested capital of $915,537,000, and in which over 51,000 persons were employed. The value of the annual production of these plants was $166,814,000.

*Reprinted from N. F. P. A. Quarterly.



Boiler Room Blower Room Generating Room

WATER GAS PLANT.

WATER GAS.

In describing the manufacture of this gas, the Lowe system of manufacture will be followed, as that system is the one that is used to the greatest extent. Few of the other processes of manufacturing this gas have attained any degree of importance, although several modifications of the Lowe system are used. These modifications are for economizing on ground area, and consist mainly of superimposing the carburetor and superheater to form one machine.

Water gas is the product of the decomposition of water, in the form of steam, in contact with incandescent carbon. Water is a chemical compound of two gases, hydrogen and oxygen, in the proportion, by volume, of two parts hydrogen to one part of oxygen. Incandescent carbon has a strong affinity for oxygen, uniting with it to form carbonic oxide.

The result of this reaction is a mixture of two gases, carbonic oxide and hydrogen, theoretically in equal volumes. Under ordinary working conditions a very small amount of carbonic acid is also formed, thus slightly reducing the proportion of carbonic oxide.

This mixture of carbonic oxide and hydrogen is known as non-luminous or "blue" water gas, and has a calorific value of approximately 300 British thermal units.

The fact that water could be decomposed in the presence of incandescent carbon has been known for more than one hundred years. In 1780 an Italian named Fontana published the results of his experiments with this reaction.

Commencing with 1824, attempts were made to carburet or enrich non-luminous water gas and make it suitable for illuminating purposes.

The first attempt to manufacture and distribute carbureted water gas, on a commercial scale, was made by Michael Donovan in 130. The blue water gas was carbureted with volatile hydrocarbons, and this gas was experimented with for lighting the streets of Dublin. The scheme was not a success.

Another attempt was made in 1846 by J. P. Gillard, but this also proved unsuccessful. In the next forty years no less than sixty patents were taken out for methods of manufacturing and carbureting water gas.

The discovery and development of the oil fields of Pennsylvania and Ohio and the invention of the generator-superheater apparatus by Prof. T. S. C. Lowe of Philadelphia Pa., made possible the successful and economical production of carbureted water gas.

During the early days of the development of the Lowe apparatus, a number of methods and processes for manufacturing carbureted water gas were experimented with. In some

cases temporary success was attained. The earlier and cruder methods were based on the utilization of apparatus of the coal gas type, making water gas in externally heated retorts or chambers.

The next step in advance was to combine a generator for producing blue water gas with a system of externally-heated retorts for fixing the oil vapors. In both of these methods it was necessary to use a light oil, generally naphtha.

The latter produced a gas of good quality, but the apparatus was complicated, expensive and lacked flexibility. From the fire hazard standpoint it was dangerous.

THE BASIC PRINCIPLES

of the Lowe system are the use of a generator and superheater, both iron shells lined with fire brick, the former being provided with grate bars, air blast and steam connections, the latter being filled with loosely piled checker brick to give fixing surface.

In the generator, non-luminous water gas was produced by the dissociation of steam in contact with carbon (in the form of anthracite coal) previously heated to incandescence by means of a forced blast of air. The superheater was brought to a suitable temperature for breaking up and fixing oil vapors by the combustion within it of carbonic oxide formed during and by the passage of the air blast through the fuel in the generator. Oil was introduced into the superheater coincident with the generation of non-luminous water gas in the generator, and by contact with the heated fire brick surfaces the oil vapors were gasified and fixed in the presence of non-luminous gas and during their passage through the superheater. The process is intermittent; first, a period of blasting to bring the carbon in the generator to the proper temperature, and by complete combustion of the blast gases in the superheater to bring the checker brick to the proper temperature for fixing the oil vapors; second, a period of gas production.

The early forms of the Lowe apparatus were designed for and only suitable for the use of naphtha for carbureting. At that period naphtha was a product of the distillation of crude oil, for which there was little demand or use; and the oil refiners had great difficulty in disposing of it. Its utilization in the manufacture of gas meant economic progress.

In the course of a few years, however, newly discovered uses for naphtha increased the demand for it to such an extent that its availability for gas-making purposes was threatened. The design of the Lowe apparatus was then improved so that crude oils could be used efficiently. One of the most important features of these improvements was the addition of another superheater, thus evolving successfully what has been known since as the

"double superheater" apparatus, which has become standard in water gas manufacture.

The increased demand for crude oils made it necessary to use a by-product for which there was no particular demand, for a carbureting material. This became known as "gas oil." The apparatus was later developed to use Texas oils, which are rich in sulphur, and also gas-house coke as well as anthracite coal.

THE MATERIALS THAT CAN BE AND ARE USED

at the present time in the generator are: gas-house coke, by-product coke, oven or beehive oven coke, Pennsylvania and Welsh anthracite coals. It is known that in one case sawmill refuse has been employed. For carbureting materials gas oils or crude oils are used. In case of emergency, naphtha and other similar distillates can be used successfully.

The gas-making apparatus consists of three separate upright shells placed on the same foundation level and connected so as to practically form one continuous vessel. The first is the generator; the second, the carburetor, and the third the superheater.

The generator and carburetor are connected together near the upper heads; the carburetor and superheater are connected near the bottom, these connections being lined with fire brick. The tops of both generator and carburetor are at the level of the working floor. The superheater extends about seven feet above the floor.

Each of these three shells is lined with fire brick. In smaller sets the generator only is double lined, while in larger sets all three shells are double lined. The interior of both carburetor and superheater is filled with fire brick, placed loosely in tiers, in such a way as to break joints and baffle the gas in its passage through; thus keeping it in more intimate contact with the heated surfaces.

IN THE OPERATION,

the generator being filled with a deep fire of coke or coal, a blast of air from a blower is admitted in the bottom of the generator, underneath the grate, and passes through the fuel. The oxygen of the air unites with the heated carbon to form carbonic oxide. The nitrogen is not affected. These two gases, carbonic oxide and nitrogen are termed the products of partial combustion, the meaning of which is that if more oxygen be added, the carbonic oxide will ignite and burn to carbonic acid. These products of partial combustion are thus burned in the carburetor and superheater by admitting air from the blower. The result of this combustion is intense heat, which is taken up by the loose fire brick, or checker brick with which the

carburetor and superheater are filled. The resulting carbonic acid nitrogen—products of complete combustion—then pass off to the atmosphere through a stack valve. The degree and distribution of heat in the carburetor and superheater are entirely under control and can be adapted to the character of the oil used in the carburetor.

When the temperature in all shells is at the proper point, shown by electric pyrometers, the air blasts are shut off and all combustion ceases.

The stack valve is then closed and steam is admitted under the grate in the generator. The passage of this steam through the highly heated fuel produces non-luminous water gas. At this gas enters the top of the carburetor, it meets a spray of partially vaporized oil. The gas and oil vapors pass together over the highly heated surfaces of the carburetor and superheater and the oil vapors are gasified and fixed in the presence of non-luminous water gas. The result is a thoroughly fixed and permanent illuminating gas. When the heat is reduced to a point where it is no longer advantageous to continue the run the oil and steam are shut off, the stack valve is opened and a period of air blasting takes place.

The gas then passes for purification and storage. From the superheater, near its top, proceeds the gas outlet pipe, leading down to a small vessel which acts as a tar extractor and in which the end of the gas outlet pipe is sealed in tar. In the vertical outlet pipe is placed a smaller pipe, through which the oil passes on its way to the carburetor, being heated by the hot gases, and entering the carburetor in a partially vaporized state. The gases, after dipping under the tar seal and having much of the tarry matters extracted, due to the lowering in temperature of the gas, pass into a scrubber and a condenser and thence out of the house to a relief holder in the yard.

The scrubber is a vessel about six feet in diameter and twenty feet high. The gas enters the bottom of this under a water seal and passes up through a checkerwork of bundles of wood over which water is sprayed at the top. The condenser consists of a large upright cylinder filled with two-inch pipes through which cold water circulates, and around which the gas passes. This lowers the temperature of the gas and like the scrubber causes further separation of tar. All tar finds its way to the tar well, usually provided underground, where the water and tar are separated and the tar, in many cases, used for boiler fuel for generating steam. The oil tars thus obtained are not so useful for commercial purposes as the tars obtained from coal gas manufacture which are sold as a by-product.

The object of the relief holder is to change the intermittent feature of production to one of steady and constant flow throughout the remaining processes. In some plants the relief holder

is weighted in such a way that the gas is forced, instead of being pumped, through the remaining apparatus.

From the relief holder the gas goes through a large upright cylindrical vessel, called the shaving scrubber, as contrasted from the first scrubber sometimes called the washer scrubber, which is filled with dry wood shavings. The action in this scrubber is to take out all moisture and what little tar remains in the gas.

The gas, at this stage, is not fit for distribution, as it contains impurities, those which it is necessary to remove being carbonic acid and sulphureted hydrogen. Therefore, the gas is passed through the "oxide purifiers," which are large, shallow, cast-iron, box-shaped vessels filled with screens. The gas passes up through these screens which, being covered with a mixture of iron filings, soft wood and sometimes slacked lime, remove the impurities mentioned above. When the purifying action has ceased, simply exposing the inert mixture to the action of the air for a while restores its properties until after repeated use it becomes so charged with free sulphur that it is no longer serviceable.

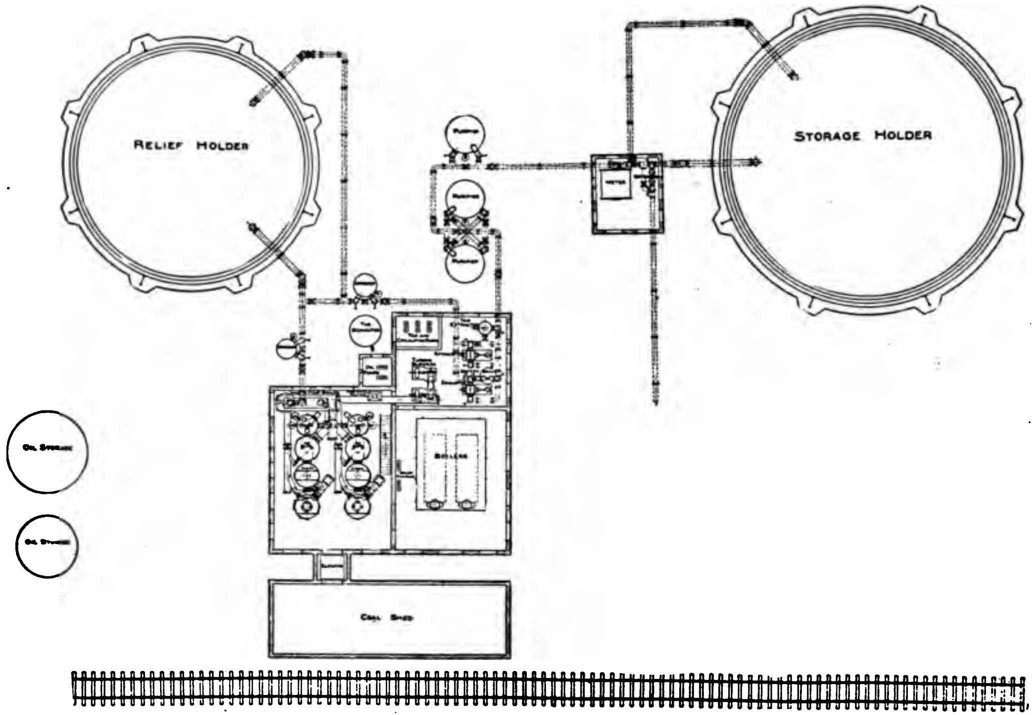
When the use of sawmill refuse known as "cypress hog" or "pine hog" is employed in the generator, the dry scrubber and even the tar extractor may be omitted, as there is very little tarry matter in the gas.

From the purifiers the gas passes through meters to the storage holders, ready for distribution.

COAL GAS.

The discovery that the distillation of coal and other carbonaceous substances produced an inflammable and more or less luminous gas was made prior to 1690, but it was not until nearly one hundred years later that the idea of using this gas for illuminating purposes was conceived. Then this use seems to have been thought of independently by several persons in different countries at about the same time, and consequently there is a dispute as to who should be accredited as having been the originator of the use of coal gas as an illuminant.

Apparently J. P. Minckelers, a professor in the University of Louvain, in Belgium, in 1784, distilled powdered coal, for the production of inflammable air which he used to fill balloons. In a report advocating the use of coal gas for aeronautical purposes, in which he was particularly interested, he is said to have mentioned the fact that the gas might be purified by being passed through lime water and could be used for illuminating purposes. It is also claimed that records in the archives of Louvain show that in 1785 Minckelers lighted his lecture room with inflammable air produced by the distillation of coal.



Typical Layout for Large Water Gas Plant.

THE EARLIEST PATENT

taken out in England, in connection with the distillation of coal, was that of Lord Dundonald, for the production of different substances from the distillation of coal, obtained in 1785. His object, however, was the production of tar, and while he is said to have lighted the hall of Culross Abbey with crude coal gas in 1787, he apparently did nothing further along the lines of illumination by means of coal gas.

William Murdock, who is credited as being the originator of the use of gas for illuminating purposes, apparently began experimenting along this line at Redruth, Cornwall, in 1792. In that year he distilled coal, peat, wood and other carbonaceous bodies, and being impressed by the quantities of gas given off during distillation and the facility with which a brilliant light was produced by this means, he made experiments to determine the relative costs of light so obtained and that obtained from oils and tallow. In 1797 he lighted his own premises with coal gas and later other buildings.

The man, however, who probably was the greatest factor in hastening the introduction of the public supply of gas was Frederick A. Winsor. He was struck with the possibilities of the process, and after much labor and time promoted a National Light and Heat Company in London in about the year 1808. In 1809 he lighted with gas a portion of one side of Pall Mall, this being the first public street lighted by means of coal gas. Even with the crude apparatus used in these times it was found that lighting by means of coal gas was much cheaper than by means of candles, which was the general practice at that time.

By 1815 the London and Westminster Chartered Gas Light and Coke Co., also formed by Winsor and his associates, had installed three manufacturing plants and fifteen miles of street mains. Other companies were soon organized and the business of supplying gas progressed so rapidly in Great Britain that in 1829 more than two hundred gas companies had been formed.

THE FIRST USE OF COAL GAS AS AN ILLUMINANT

in the United States is said to have been made in Philadelphia in 1796, but the first definite record of such use in this country is the lighting in 1806 by David Melville of his house in Newport, R. I., with gas made by himself. In 1813 he lighted with gas some mills in the vicinity of Newport.

The first gas company in the United States was organized in Baltimore in 1817, and this was followed by the organization of companies in Boston and New York, but because of the comparative cheapness of other illuminants progress was slow, and up to 1830 these were the only cities that had gas works.

Coal gas as manufactured for illuminating or heating purposes is made by the destructive distillation of coal in retorts externally heated.

THE CLASSES OF COAL USED

for the purpose are confined to those varieties which are bituminous in their nature, yielding, upon distillation, the greatest possible amount of volatile hydrocarbons. Bituminous coals have the property not possessed by the anthracites, of softening and apparently fusing when subjected to a temperature below that at which combustion would take place. Coals having a large percentage of hydrogen yield more volatile substances at the temperature of distillation and less carbonaceous residue than others which contain less hydrogen and more carbon, the latter approaching anthracite in composition. Anthracite is, therefore, valuable for the manufacture of water gas, as it contains larger amounts of carbon.

There are two classes of coals which are bituminous in their nature called "coking" and non-coking coals. These are much the same composition, but the latter does not possess the quality of fusing to a compact mass and is therefore used for steam boiler firing.

As the coking coals, which are used in coal gas manufacture, come in large lumps, it is necessary to crush them into small pieces before being used in the retorts.

The retorts as made in recent years are universally of some form of fire clay. Older retorts were made of cast iron, but the destructive action of the gases made the use of the clay retorts a matter of economy in maintenance. These retorts are usually of the shape of a capital letter "D," with the flat side for the bottom. But retorts of oval or even circular shaped cross-section are often used. The dimensions vary, but are very often as follows: Width internally, 20 inches; height internally, 13 inches; thickness of walls, 3 inches, and length, about 20 feet. These are mounted, five to nine in a set or bench, horizontally, vertically or inclined at an angle of about thirty degrees with the horizontal in brick furnaces of special construction, in such a manner that the gases of combustion of the fire beneath pass around and over the retorts and out through a main flue leading to a chimney. The fuel for firing is usually coke taken from some of the retorts above after the run. Sometimes coal and in a few cases gas is used for heating the retorts on the regenerative principle.

The retorts are filled with gas coal in amounts ranging from 200 to 1,000 pounds, according to the size and serviceability of the retorts, and allowed to heat for five or six hours. The heat drives off the volatile gases which form the basis of illuminating

coal gas and leaves coke in an incandescent state. The coke is drawn out of the retorts into a trough usually fitted with a conveyor which carries it under a water spray to cool it before finally dumping it in the yard.

Retorts are charged by hand, care being taken to distribute the coal evenly over the bottom of the retort. Inclined and vertical retorts are charged from their upper ends and drawn from the lower ends. Mechanical means of charging have been devised, but were not found to give the best results and are therefore not used.

From the retorts "A" (see sketch) the gases pass up a pipe "B" called the "standpipe," with which each retort is provided. The outlet end of the standpipe dips below a water or weak ammonia liquor seal in what is termed the "hydraulic main," "C." The passage of the gas up the standpipe and through the seal lowers its temperature and causes the main bulk of the tar and ammonia to be left in this liquor. A large drum is attached below the hydraulic main of each bench and in this the tar collects. Overflow pipes from the tar drum and the hydraulic main conduct the tar and ammonia liquor to the tar well, wherein the products collect.

From the hydraulic main the gas, somewhat purified, passes to another building, and into a condenser "D," usually of an upright type, which contains tubes through which cold water circulates and around which the gas passes. Newer forms of condensers, known as atmospheric condensers, as shown in sketch, are composed of vertical pipes connected in pairs near the top, the lower ends being connected to a box containing water and which is divided by partitions so that the gas passes over the water and up and down the pipes alternately. The reduction of temperature of the gas in the condenser throws out more tar and ammonia, which find their way to the tar well.

The gas at this stage usually passes through an exhauster or pump "E" which draughts from the condenser. The gas has flowed from the retorts to the condensers due to the sucking action of this pump. From this stage on the gas is under a pressure of about five or six inches of water and is forced through the remaining apparatus to the storage holder.

The gas sometimes becomes heated again, due to the compressing action of the pump, and it is sometimes necessary to put it through another condenser to lower its temperature again.

The gas then passes through a tar extractor "F," which takes out more tar and ammonia. The gas enters an upright cylindrical vessel under a water seal and passes up through screens or grids arranged so as to baffle the gas in its passage through them. This action removes all tar that remains.

From the tar extractor the gas goes to one or two scrubbers "G" for the purpose of separating the naphthalene and ammonia

that remain, and these machines also extract a small amount of the sulphureted hydrogen. Two principal forms of scrubbers are in use: The tower scrubber and the more compact washer scrubber. The tower scrubber consists of a tall shell packed with coke, wooden checker work, or perforated iron plates, down through which a weak ammonia liquor trickles and meets the gas passing up. The washer scrubber "G" (shown in sketch) is either upright or horizontal and consists of numerous segments in each of which a shaft revolves. Bundles of wood are attached to the shaft in each segment and on a portion of the revolution these pass through a weak ammonia liquor. The gas passages are so arranged that the gas must go between the small spaces in the welted bundles of wood.

From the scrubber the gas passes to the oxide purifiers "H," as in the purification of water gas, and this removes the hydrogen sulphide still remaining, carbon disulphide and carbonic acid. The gas then is passed through meter "I" and to storage holders "J" ready for distribution.

A new system recently brought to notice has been installed in Derby, Conn., employing vertical retorts. This is known as the Woodall-Durham system, and the advantage claimed is that gas may be made continually by the use of automatic machinery. This is a new undertaking, and if proven successful will probably be used extensively in new plants.

IN GENERAL.

A great many plants manufacturing illuminating gas make both coal and water gas, though newer plants apparently tend toward water gas as being more economical, in that less labor and less yard room are required. Water gas apparatus has also the advantage of being more flexible, as gas can be produced from an idle plant in about twenty-four hours, while in coal gas plants it would take from one week to one month. For this reason, water gas is made in coal gas plants to take care of seasons of heavy consumption by their customers. The gases are mixed in the mains in various percentages, although pressures, etc., must be carefully regulated when they are mixed, as they are of different specific gravities.

Coal gas plants have coke and tar as by-products. The ammonia liquor also is sometimes sold direct as a by-product and, sometimes, by distillation and surface contact with sulphuric acid, it is reduced to ammonia sulphate and sold in that form.

Coal gas, as a by-product of coke manufacture is also sold for illuminating purposes, both in the purified and in the unpurified state. The retorts or coke ovens used for manufacturing coke are very large and are heated for about thirty hours.

Part of the gas obtained is usually used for heating the ovens and what remains is sold to companies who purify and distribute it. Methods of purification, etc., are the same as for the ordinary coal gas.

HAZARDS.

In considering the hazards, the construction of various buildings is important. These should all be fire-resistive if possible. In any event, there are certain places which must be fire-resistive, on account of the nature of the occupancy.

One of these places is the operating floor of the generator room of the water gas plant. This floor comes on a level with the top of the generator and carburetor and is subjected to considerable heat. A good form of construction for this floor and one that is often found is iron plates laid on steel "I" beams. The roof of such a generating building should also be fire-resistive and in any event the stack above the superheater must be well protected against any woodwork. A good form of construction for the roof of the generating building that is being adopted is corrugated iron laid on steel truss work.

The places corresponding to these in the retort house of a coal gas plant are the drawing and charging floors and roof. As coke is drawn from the retorts it is liable to fall in all directions before being carried away by the conveyors. This necessitates a fire-resistive form of construction for these floors. The conveyors must be of metal and must not come near woodwork, as the coke is in an incandescent state as it leaves the retort and heats the metal of the conveyor. These conveyors are sometimes run in a trough filled with water.

THE DANGER OF SPONTANEOUS IGNITION

of coal in a gas plant is probably no greater than in any plant using steam boilers. The coals used in the actual production of gas are not liable to heat spontaneously, as anthracite is used in water gas plants, and gas coal which comes in large lumps is used in coal gas plants. Neither of these coals is considered dangerous.

The purifying process by the use of oxide is one in which there is considerable hazard. Iron filings are almost universally used and these in storage are liable to heat spontaneously. Their storage should always be in a cut-off section, perfectly fireproof. The action in the purifying boxes is one that will cause spontaneous heating if allowed to take place too rapidly. Then, when the covers are removed for recharging, there may be heat enough in the sponge to ignite the gas which must necessarily be contained in the boxes and thus cause an explosion. Another cause for heating in the boxes is apt to occur

from improper mixing of the iron filings and wood shavings, so that a quantity of filings remains closely packed together. These troubles are not likely to occur in a mixture that has been used several times, as the chemical actions take place more slowly under that condition. The reviving process is usually done on the floor below the boxes. The oxygen of the air unites to separate free sulphur. This action is also a cause for spontaneous heating if carried on too rapidly, and for that reason all windows, etc., in the reviving room should be closed so that the action will take place slowly.

Recently purifying boxes are being made larger so that one box takes the place of several smaller ones, and these are being laid in open yards partly underground, with only a roof covering for protection. This form is much more desirable than having the purifying boxes located in buildings.

OTHER PROCESSES THAT NEED SPECIAL ATTENTION

are: The storage and immediate removal after use of the shavings used in the shaving scrubbers, and the storage of lime and gas oils which should be at an ample distance from all buildings.

The method of feeding gas oil to the carburetor should also be considered. The safest method, from a fire hazard standpoint, is to employ pumps which draw from a storage tank outside. In case of a fire or damage to the pump the oil in the pipes will drain back to the storage tank. A system of feed by gravity from tanks located above the carburetor would allow all

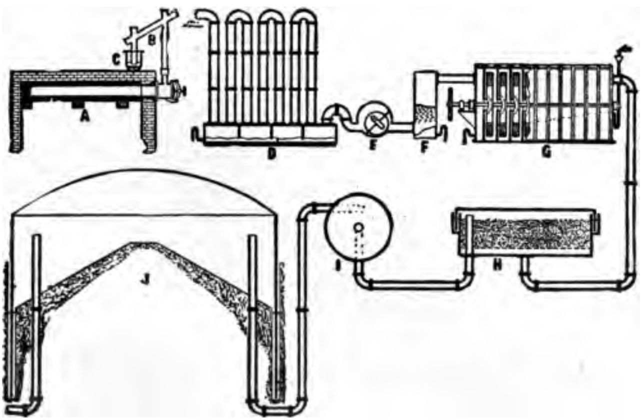


DIAGRAM OF A COMPLETE COAL GAS PLANT.

the oil in the tank to drain into the building in case of a break in a pipe. In this system, all oil piping should be located where it is least liable to breakage.

The arrangement of gas piping should be such that there is the least possibility of breakage, as a leak might liberate an enormous quantity of gas. Piping laid underground as much as possible is desirable from the fire hazard standpoint. It is also well to have at least two shut-offs in different locations for each section of piping, as it might be impossible to operate one valve in case of trouble caused by a broken or leaking pipe.

The possibility of gas leakage is present continually during the process and especially in the generator building, condenser building, purifier room, meter room, valve and governor rooms. For this reason open flames and smoking should be prohibited and all electric lighting should be installed as recommended by the National Fire Protection Association for localities where volatile inflammables are present by using double encased lamps, conduit wiring and outside switch control.

ANOTHER HAZARD

occurs in the testing of the manufactured gas for its candle power or illuminating quality. The usual method employed for this is by ordinary photometric apparatus with open flames, one burning the gas to be tested and the other a standard of illuminating power at either end of the machine. The standard light formerly used was the common candle, but of recent years the "Harcourt Pentane Standard" has come into use. The standard in this case is obtained by mixing the vapor of pentane with air and burning this mixture. Pentane is a hydrocarbon of the menthane series and is very volatile and highly inflammable. It is much more hazardous than gasolene, in that its evaporation is more rapid. It is placed in an elevated tank holding about one pint. The hazard lies in the presence of open flames and matches which are usually employed to light the flames in a small room in which an inflammable volatile liquid is freely used and stored. For the best possible arrangement the testing should be in a detached fireproof building with electrical apparatus for lighting the flames. Also all storage of pentane should be away from any building and the ventilation of these dark rooms should be investigated, as the vapors are heavier than air.

With acknowledgments for cuts and valuable information to Frank Hall Thorp's *Industrial Chemistry;* United Gas Improvement Company's *Carbureted Water Gas,* and Alfred E. Forstall, *The Technique of Gas Manufacture.*

INDEX OF ARTICLES ON FACTORY INSPECTION TO BE FOUND IN THE FIRST FIVE VOLUMES OF LIVE ARTICLES ON SPECIAL HAZARDS

CONTENTS OF LIVE ARTICLES ON INDUSTRIAL SAFEGUARDS, NUMBER ONE

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